Network Board, B-NET (Rev. 00)

All specifications subject to change without notice

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INTRODUCTION

The Datex AS/3 Network Board enables connecting the AS/3 monitor to the network. For installing the board please refer to the Installation Manual of your monitor.

I TECHNICAL SPECIFICATIONS

Meets IEEE802.3 specifications (10BASE-T)

Hospital grade approved data transformer

Coding element interface

64 Kbyte linear shared-memory/8x8Kbyte paged shared-memory

Support xxx86 real/protected mode programming

Electrical requirements	+5 Vdc/400 mA

2 FUNCTIONAL DESCRIPTION

2.1 General

The B-NET board block diagram is shown in figure 2-1.

The network interface controller is basically the heart of the B-NET board. The interface controller communicates with the CPU board through the data and address buffering and decoding block, or through the RAM. During the startup sequence the CPU board loads the network communication software into the RAM. The processor then executes the communication software.

The network interface controller transmits data packets to the AS/3 Network and receives data packets from the network through the 10BASE-T transformer. The transformer filters and transforms the data and also provides the isolation.

The Ethernet status LEDs indicate the status of the network communication. The status LEDs are controlled by the network interface controller. The LEDs are not visible when the board is installed into the monitor.

The coding element interface block contains a unique network address. The interface block is connected to the coding element. The coding element contains information on the monitor location. The network address and the monitor location information are transmitted to the CPU board through the data and address buffering and decoding block.

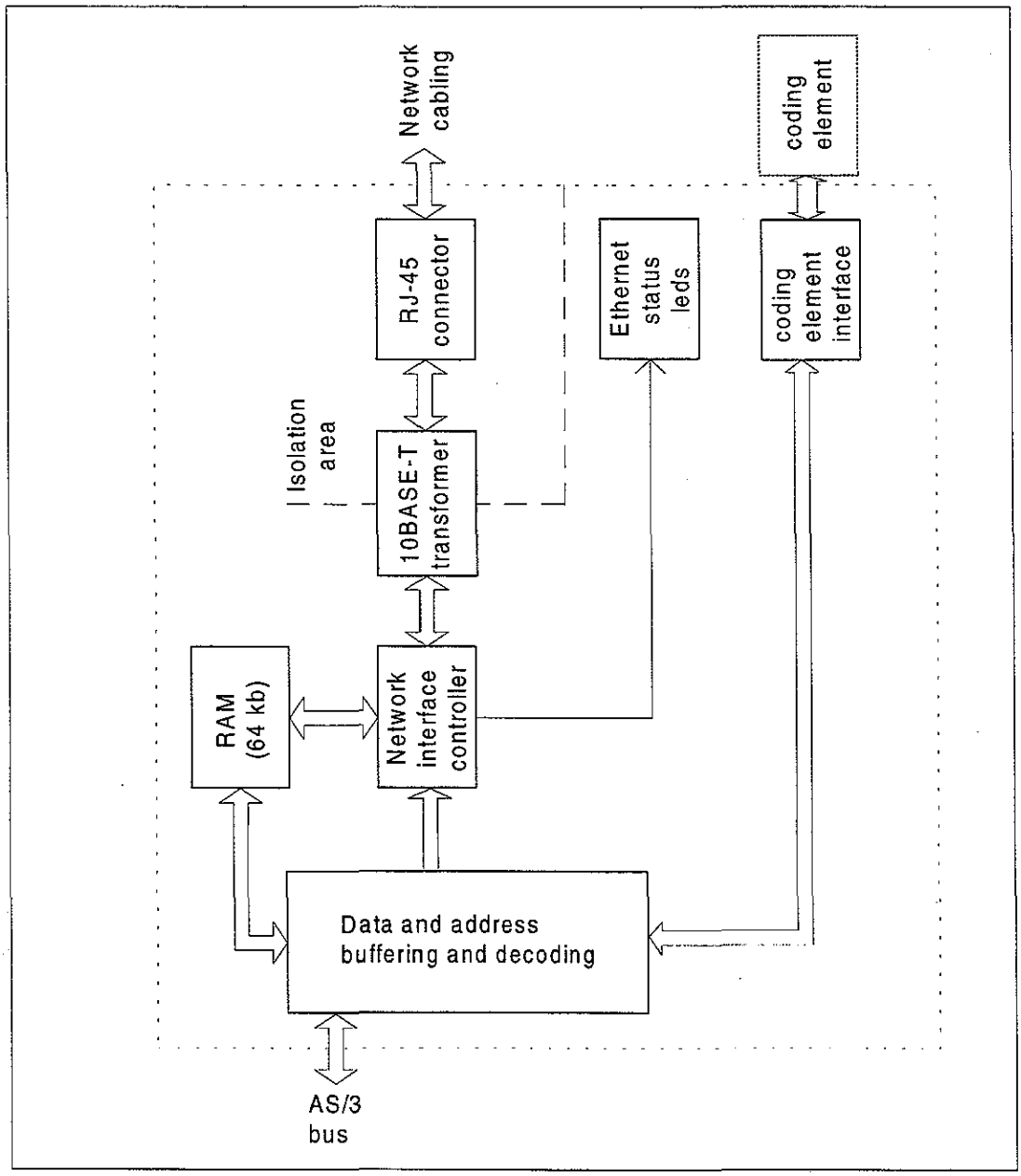


Figure 2-1 B-NET Block Diagram

2.2 Control Logic

Adapter board consists of the following parts:

- IO-decoding
- buffer memory page selection and series EEPROM control register
- memory decoding and interrupt selection register
- memory decoding
- buffer memory page selection and series EEPROM status buffer
- coding element interface
- bus arbitration

2.3 Coding Element Interface

At the edge of the adapter board there is a 9 -pin female D-connector, see Chapter 2.5 Connectors and Signals.

2.4 Ethernet Interfaces

The data transformer is designed by Datex and hospital grade approved.

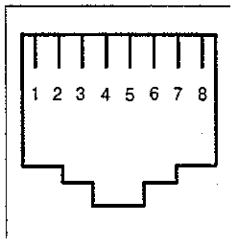
Adapter's 10BASE-T interface is a normal interface with 7-pole butterworth low-pass filter on unisolated transmit side of the transformer and 7-pole butterworth lowpass filter on unisolated receive side of the transformer. On the isolated side of the transformer there is a common mode choke both for transmitting and receiving lines.

There are also two pairs of LEDs indicating following things:

- transmission to Ethernet	(V14)	Green
- receiving from Ethernet	-"-	Yellow
- collision detection	(V15)	Yellow
- good link in 10BASE-T interface	-"-	Green

2.5 Connectors and signals

The pin assignments on the external Network Connector locating on the Network Board are as follows.



Pin	Signal
1	Tx +
2	Tx -
3	Rx +
4	N/C
5	N/C
6	Rx -
7	N/C
8	N/C

9-pin female D-connector (X2):

Pin	Signal
1	IDCS1 (chip select)
2	IDCL (clock)
3	IDDI (data in)
4	IDDO (data out)
5	IDPE (protect enable)
6	+5Vdc
7	unused
8	unused
9	gnd

CPU Bus connector (X1):

	a	b	c
1	+15 V	AGND	DGND
2	-15 V	BALE	DGND
3	SA0	SA1	DGND
4	SA2	SA3	RESET_RS485
5	SA4	SA5	-RESET_RS485
6	SA6	SA7	DATA_RS485
7	SA8	SA9	-DATA_RS485
8	SA10	SA11	TXDD_RS232
9	SA12	SA13	RXDD_RS232
10	SA14	SA15	BIT0IN
11	SA16	SA17	BIT1IN
12	SA18	SA19	TXDC
13	SA20	SA21	RXDC
14	SA22	SA23	RTSC
15	-SMEMR	-SMEMW	CTSC
16	-IOR	-IOW	TXDB
17	CLK	-RESET	RXDB
18	-IOCHRDY	IRQ10	RTSB
19	N/C_1	IRQ11	CTSB
20	N/C_2	IRQ12	TXDA
21	-SBHE	IRQ15	RXDA
22	SD0	SD1	RTSA
23	SD2	SD3	CTSA
24	SD4	SD5	LOUDSPEAKER
25	SD6	SD7	+5 V
26	SD8	SD9	+5 V
27	SD10	SD11	+5 V
28	SD12	SD13	+5 V
29	SD14	SD15	ON/STBY
30	+15 VD	-RESET_CPU	+5 V_CPU
31	+15 VD	+32 VD	REFRESH_WD
32	GNDD	GNDD	POWER_FAIL

2.5.1 Extension Lead

Every B-NET Board is equipped with an Extension Lead which facilitates the connecting and disconnecting the cable.

3 SERVICE PROCEDURES

Due to the nature of the Network Board, field service for the board is limited to troubleshooting. The boards are returned to Datex for repair.

Datex is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

CAUTION: Only trained personnel with appropriate tools and equipment are allowed to perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

Please, refer to the Installation Manual of your monitor for information on how to remove the Network Board.

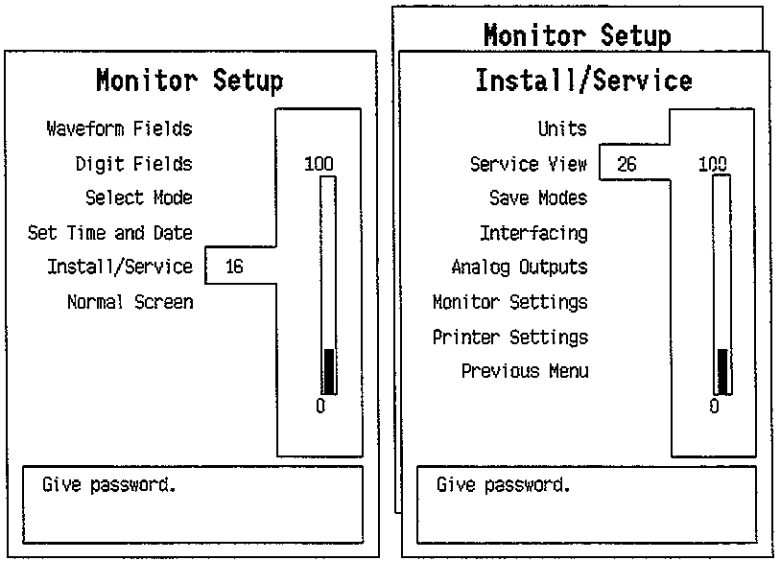
4 TROUBLESHOOTING

Symptom at the monitor end	**Problem at**	**Explanation/correction**
Monitor does not connect to network. Monitor connects to network, but disconnects unexpectedly (*"Network connection down"* message on the monitor screen).	Patch panel	Patch cable not connected to HUB or to panel.
	Patch cable	Patch cable or connector defective.
	HUB	HUB not connected to power supply.
	HUB	HUB port closed due to physical layer problems.
	HUB	HUB port temporarily closed and reopened due to physical layer problems.
	HUB	HUB's not properly connected to each other.
	Monitor-Network cable	Cable not properly connected to wallplate or to monitor.
	Monitor-Network cable	Cable or connector defective.
	Network board	The network board is defective. The board cannot be used. See network service page for details.
	Network board EEPROM	The EEPROM of the network board is defective or uninitialized. The board cannot be used. See network service page for details.
	Identification plug	There is no Identification plug properly attached to the monitor.

	Identification plug	The identification plug is defective or uninitialized. The plug cannot be used
"Network EEPROM Error" message shows on the monitor screen	Network board EEPROM	The EEPROM of the network board is defective or uninitialized. The board cannot be used. See network service page for details.
"Check network connectors" message shows on the monitor screen	Monitor-Network cable	Cable not properly connected to wallplate or to monitor.
	Monitor-Network cable	Cable or connector defective.
	Identification plug	There is no identification plug properly attached to the monitor.
	Identification plug	The Identification plug is defective or uninitialized. The plug cannot be used. See network service page for details.
"Network board error" message shows on the monitor screen	Network board	The network board is defective. The board cannot be used. See network service page for details.
	Network board EEPROM	The EEPROM of the network board is defective or uninitialized. The board cannot be used. See network service page for details.
Other Site View shows no waveforms	No waveforms are set up for Monitor-to-monitor communication	Run AS/3 Network Setup to verify current Monitor-to-monitor communication set up.
Network printing fails	Print server is busy	Network manager's print server is busy at the moment and cannot take more print jobs. Try again after 15 seconds.
	Print queue is full	There are too many unprinted documents waiting in the print queue. Check the printer, as it is not operating properly.

	Printer is off-line	Printer cable is loose, printer is out of paper, there is paper jam or the printer is simply switched to off-line state.
Record keeper menus are blank	There are no menus for the record keeper	Run AS/3 Network Setup to verify the current set up.

5 SERVICE VIEW



To enter Service Menu during normal operation:

1. Press the MONITOR SETUP key.
   The Setup menu appears.

2. Turn ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34.
   The Install/Service menu appears.

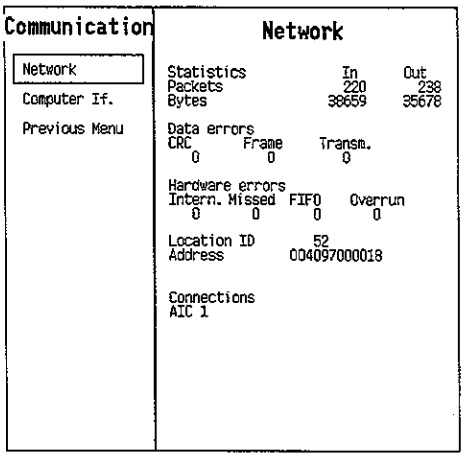
4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

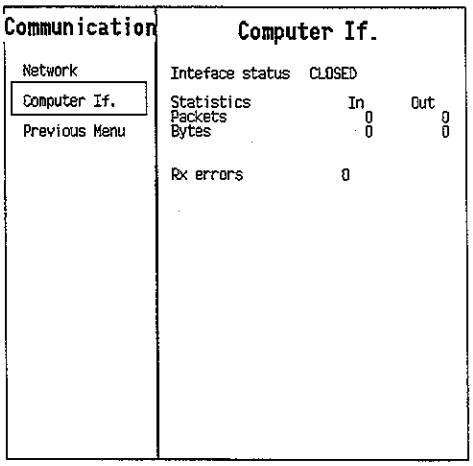
6. Turn the ComWheel to highlight "Monitor" and push.

7. Turn the ComWheel to highlight "Communication" and push.

8. Under Communication there are two service views about networking: Network , and Computer Interface. Highlight the desired one and push ComWheel.



Network displays network related service data. Please see the chart on the next page.



Computer If. displays computer interface related service data.

Interface status indicates if the connection is closed, opened or active. Closed indicates that the necessary hardware is not present or is not available, Opened indicates that the hardware and software for the interface is running, but there is no network connection or that there has been errors in using the interface (e.g., no cable connected), and active indicates that the interface is operating normally.

Rx errors indicates the number of received erroneous packets.

In the Network menu there are additionally following items that describe the communication in the network.

Value	Usage	Notes
Received packets (Statistics In/Packets)	Total number of received packets since last cold start.	
Transmitted packets (Statistics Out/Packets)	Total number of transmitted packets since last cold start.	
Received bytes (Statistics In/Bytes)	Total number of received bytes since last cold start	
Transmitted bytes (Statistics In/Bytes)	Total number of transmitted bytes since last cold start	
CRC errors (CRC)	Number of received packets with incorrect checksum.	
Frame errors (Frame)	Number of received packets with incorrect frame structure.	Refers to physical layer problems. An erroneous packet often has both frame and CRC error.
Transmission errors (Transm.)	Number or errors in packet transmission.	
Internal errors (Intern.)	Internal error of the network board.	Must always be 0.
Missed packets (Missed)	Number of received packets lost due to overload.	Must always be 0.
FIFO errors (FIFO)	Internal error of the network board.	Must always be 0.
Overrun errors (Overrun)	Practically same as above.	Must always be 0.
Location ID	Monitor's location given at the setup	
Address	Monitor's ethernet address	
Connections	Names of AICs connected	

6 SPARE PARTS

Network Board, B-NET

Item description	Order No.
Grounding plate	885414
Network cable extension	*713698

* = the part is recommended for stock

7 EARLIER REVISIONS

There are no earlier revisions of B-NET.

Interface Board, B-INT (Rev. 00)

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INTRODUCTION

The B-INT board provides an interface between AS/3 Anaesthesia Monitor and other monitors connected to it. It also provides a connection between the monitor frame and the Airway Module.

The list of the monitors that can be interfaced, and parameters available from them, is in the installation manual of your monitor.

1 SPECIFICATIONS

1.1 Serial I/O Definitions

- RS-232 buffered (channels 1-4)
- All standard baud rates are possible from 300 to 115200
- Every interfaced device has fixed baud rate.

1.2 Analog Definitions

- There are four analog inputs available on channel 1 and 2.
- All analog inputs are Op-Amp buffered, with input impedance of 1 MΩ. Each of these analog inputs are also equipped with a 1 MΩ pull-down resistor to -12 V for NC-detection.
- Sampling rate: 10 ms/sample/channel
- Input range: -10 V - +10 V
- Resolution: 10 bits -> 1024 voltage levels in range

2 FUNCTIONAL DESCRIPTION

B-INT detects and identifies the specified monitors connected to its four 9-pin connectors (one D-connector and three pin row connectors). The identification is made by a serial string.

There are three pin row connectors on the board surface. Two for serial and analog connectors (for all interfaces) and one for serial and digital connector.

In the back panel of the board there are two connectors; a 9-pin serial D-connector and a 25-pin D-connector. The 25-pin D-connector is used for connecting the Airway Module (as the Gas interface board is removed when B-INT is installed).

If both numerical and analog real time waveforms are desired, the external monitor can be connected to the serial/analog connectors (X7 and X8) using additionally interface connector cable.

For detailed installation instructions please refer to AS/3 Anaesthesia Monitor Installation Manual.

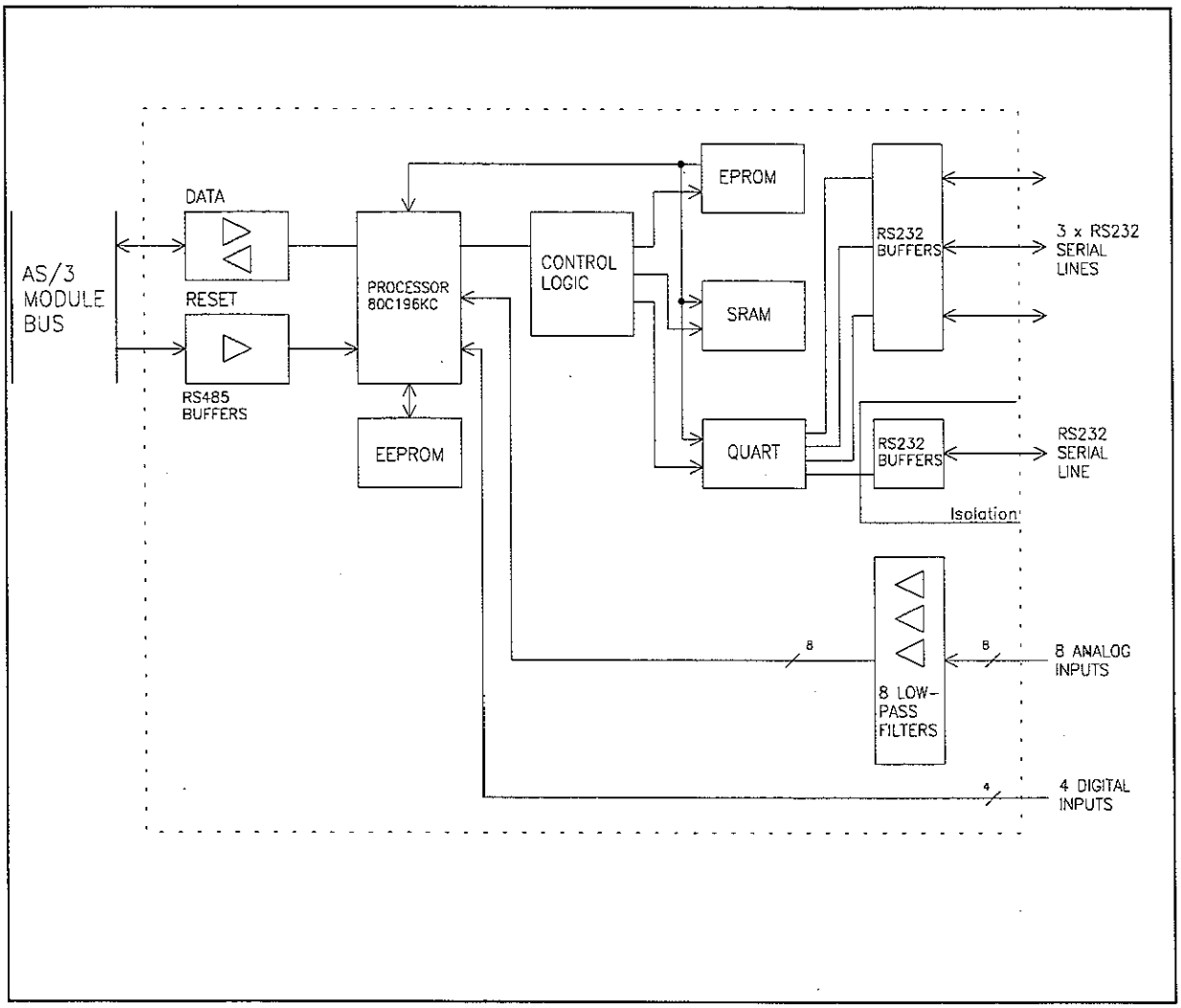


Figure 1 B-INT Block Diagram

2.1 Main Components

In general

The board contains 80C196KC16 (Intel) microcontroller.

External connections

The connectors of the board are:

- 96-pin E-connector to the CPU mother board (X1)
- 25-pin D-connector for an Airway module (X2).
- 9-pin D-connector. It is RS-232 level isolated serial connector (X3). No analog inputs available.

In addition, three connectors on the board make the following connections possible with AS/3 interface connector cable:

- RS-232 level serial and analog connectors for all interfaces (X7, X8).
- RS-232 level serial and digital connector (X9).

X7 and X8 connectors are for analog inputs (four inputs each) and X9 connector is for digital inputs (four inputs). Analog real-time waveforms are interfaced through X7 and X8 connectors. Also X3 and X9 connectors can be used to interface waveforms from Dräger Cato and Cicero.

The board is connected to the AS/3 module bus through the CPU mother board.

Serial communication signals for transmitting (TxD) and receiving (RxD) are sent to the microcontroller ports. The direction of the communication is controlled by REC/SND/ signal at the buffers. RESET/ signal always reset the communication to RxD state.

Reset

The Interface board is resetted when AS/3 Central Unit is reset (MAIN/RESET/) or when the module bus is reset (RESET_RS485).

The RESET/ signal is sent to address decoding GAL circuit, from which it goes to the microcontroller as RESET/Z. When the RESET/ is active (low), the RESET/Z also goes low and resets the microcontroller.

Serial communication channels

For four serial communication channels (TxD, RxD), there is a QUART. The microcontroller is able to reset the QUART any time by pulling QRESET signal high. The QUART is also reset when the microcontroller is reset; the microcontroller pulls all the port 1 signals high when it resets.

Memories

On the board there is static RAM, EPROM, EEPROM and address decoding GAL unit.

The microcontroller communicates with the EEPROM in serial mode.

Digital inputs

Four digital inputs are connected to connector X9 on the board. They are passed through to the microcontroller's high speed pins (DIGBUS). The digital inputs have an overvoltage protection and a pull-up circuit.

Analog inputs

Eight analog inputs are connected to connectors X7 and X8. They are passed through EMI filters and low-pass filters to the microprocessor's port 0.

Power test connector

There is a power test connector X4.

Pin No	Signal
1	+5 Vref
2	+5 V
3	+12 V
4	DGND
5	-12 V
6	NC

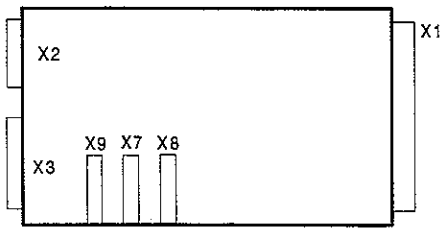
Analog test connector

This connector is for factory tests only.

Fuse

A fuse of 4 A is installed on the board for +24/+32 Vdirty input voltage. This voltage is not used on the board but passed through to 25-pin D-connector on the connector plate for Airway module use.

2.2 Connectors and signals



AS/3 Bus connector (X1):

	a	b	c
1	+15 V	AGND	DGND
2	-15 V	BALE	DGND
3	SA0	SA1	DGND
4	SA2	SA3	RESET_RS485
5	SA4	SA5	-RESET_RS485
6	SA6	SA7	DATA_RS485
7	SA8	SA9	-DATA_RS485
8	SA10	SA11	TXDD_RS232
9	SA12	SA13	RXDD_RS232
10	SA14	SA15	BIT0IN
11	SA16	SA17	BIT1IN
12	SA18	SA19	TXDC
13	SA20	SA21	RXDC
14	SA22	SA23	RTSC
15	-SMEMR	-SMEMW	CTSC
16	-IOR	-IOW	TXDB
17	CLK	-RESET	RXDB
18	-IOCHRDY	IRQ10	RTSB
19	N/C_1	IRQ11	CTSB
20	N/C_2	IRQ12	TXDA
21	-SBHE	IRQ15	RXDA
22	SD0	SD1	RTSA
23	SD2	SD3	CTSA
24	SD4	SD5	LOUDSPEAKER
25	SD6	SD7	+5 V
26	SD8	SD9	+5 V
27	SD10	SD11	+5 V
28	SD12	SD13	+5 V
29	SD14	SD15	ON/STBY
30	+15 VD	-RESET_CPU	+5 V_CPU
31	+15 VD	+32 VD	REFRESH_WD
32	GNDD	GNDD	POWER_FAIL

Rear Panel 9pin male D-connector (X2)

Pin No	I/O	Signal
1		N/C
2	I	RXD RS
3	O	TXD RS
4	O	+5 V
5	O	GND
6		N/C
7	O	RTS RS
8	I	CTS RS
9		N/C

CH 4 (non-floating, off-board D9-connector, X9):

Pin No	Definition
1	D0 digital input
2	RXD
3	TXD
4	D1 digital input
5	GND
6	D2 digital input
7	RTS
8	CTS
9	D3 digital input

Module Bus Connector (X3)

Pin No	I/O	Signal
1	O	RESET_RS485
2	O	-15 VDC
3	O	+15 VDIRTY
4	O	+15 VDC
5	I/O	-DATA_RS485
6	I/O	DATA_RS485
7		Ground & Shield
8	O	-RESET_RS485
9	O	CTSB
10	I	RTSB
11	O	RXDB
12	I	TXDB
13		Ground & Shield
14	O	+32 VDIRTY
15	O	GroundDIRTY
16	O	CTSC
17	I	RTSC
18	O	RXDC
19	I	TXDC
20		ON/STANDBY
21		BIT0IN
22		RXDD_RS232
23		TXDD_RS232
24	O	+5 VDC
25	O	+5 VDC

Connectors for channels 1..4 are 9 pin male D-types, and their pins are described below:

CH 1 (non-floating, off-board D9-connector, X8):

Pin No	Definition
1	A0 analog input
2	RXD
3	TXD
4	A1 analog input
5	GND
6	A2 analog input
7	RTS
8	CTS
9	A3 analog input

CH 2 (non-floating, off-board D9-connector, X7):

Pin No	Definition
1	A4 analog input
2	RXD
3	TXD
4	A5 analog input
5	GND
6	A6 analog input
7	RTS
8	CTS
9	A7 analog input

3 SERVICE PROCEDURES

3.1 General Service Information

Usually field service is limited to replacing the faulty circuit board. The board is then returned to Datex for repair.

Datex is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

CAUTION: Only trained personnel with appropriate equipment shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

4 TROUBLESHOOTING

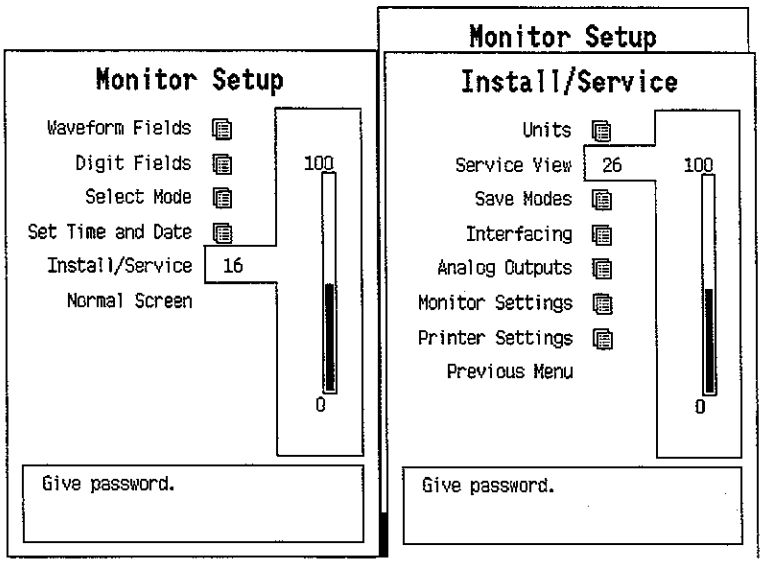
Enter the start Service View, see chapter Service View, 5. Select Scroll Vers and scroll down the SW version/Unit id list. Make sure that the software code and level, control and serial numbers of B-INT are displayed under SIO (B-INT).

If those are not displayed, B-INT is faulty.

TROUBLE	CAUSE	TREATMENT
B-INT not active in the Service View.	Board is not connected properly. B-INT faulty	Check that the board is firmly pushed into the connector. Replace B-INT board and send it for repair.
Measured values from the interfaced monitor do not appear on the display after appr. one minute.	Monitor not selected for interface. Poor contact in the interface cables. Wrong interface cable.	Select right monitor in menu Install Service/Interfacing. Check the cables and connections. Change the cable to another connector. Check cable type and change accordingly.

5 SERVICE VIEW

To enter the Service View:



1. Press the MONITOR SETUP key.
   The Setup menu appears.

2. Turn ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34.
   The Install/Service menu appears.

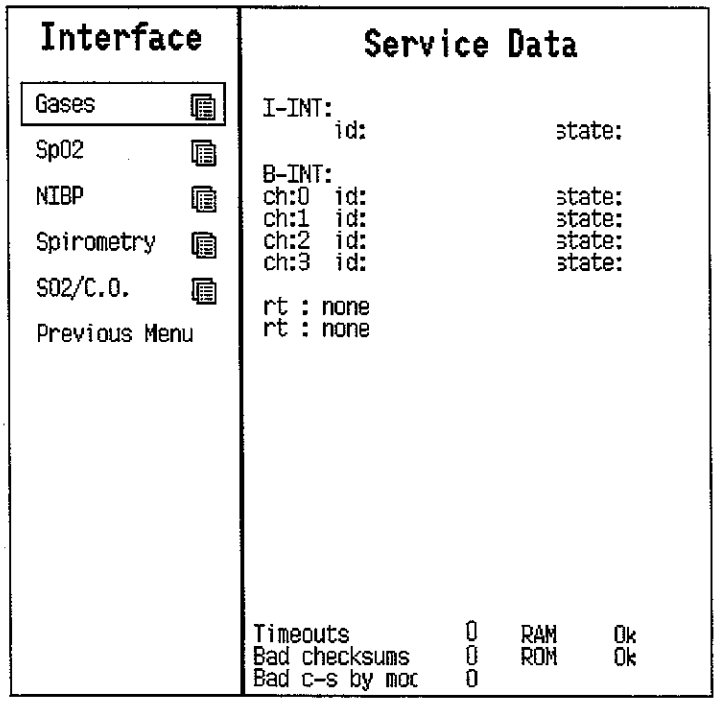
4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

6. Turn the ComWheel to highlight Modules and push.

7. Turn the ComWheel to highlight the Interface and push.

Service Data



Gases, SpO_2, NIBP, Spirometry, SO_2/C.O indicates the parameters of which service data is available. The data which can be seen from those pages is raw data of the interfaced monitors, which will be processed for the normal screen.

I-INT Indicates the status of the interface via UPI board.

B-INT Indicates the status of interface via the 4 interface channels of B-INT.

id: The name of the interfaced monitor, e.g. Ultima

state describes the state of the connection, alternatives are:
'init ' -> the channel is initialized
'wait ' -> AS/3 monitor is waiting the external monitor
'online' -> the connection is ready
'search' -> the external monitor is searched

rt: real time values that are available via interface .

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.
Bad checksums is a cumulative number that indicates how many times communication from the module to monitor broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The AS/3 Monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50 per second) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

RAM indicates the state of the external RAM memory.
ROM indicates whether the checksum in the EPROM is in accordance with the one the software has calculated.
The state is either **OK, Fail** or **?** (module not in place or a communication error).

6 SPARE PARTS

NOTE: Accessories are listed in the AS/3 Anaesthesia Monitor Supplies and Accessories.

Interface Board, B-INT

Item description	Order No.
Fuse T4A	*51134
Grounding plate	885404
AS/3 Interface connector cable	*882353

* the part is recommended for stock

7 EARLIER REVISIONS

There are no earlier revision of B-INT, only software changes have been made.

Airway Module, G-O (Rev. 00)

Airway Module, G-OV (Rev. 00)

Airway Module, G-AO (Rev. 04)

Airway Module, G-AiO (Rev. 03)

Airway Module, G-AiOV (Rev. 02)

Airway Module, G-AOV (Rev. 02)

Gas Interface Board, B-GAS (Rev. 01)

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GENERAL DESCRIPTION

The AS/3 Airway Modules, G-O, G-OV, G-AO, G-AiO, G-AOV and G-AiOV provide airway and respiratory parameters followingly:

All modules have a side-stream gas sampling system providing measurements of CO_2 and O_2. The G-AO module can also measure N_2O and anaesthetic agents. The modules G-AiO and G-AiOV can additionally identify the anaesthetic agent used. The modules G-OV G-AOV and G-AiOV provide the Side Stream Spirometry measurement which enables the measuring of respiratory parameters near the patient.

Gas Interface Board, B-GAS is used for connecting an Airway Module to the Central Unit. The connection can also be made through the Interface Board, B-INT.

This service manual section provides information required to maintain and repair the Datex AS/3 Anaesthesia Monitor Airway Modules, G-O,G-OV, G-AO, G-AiO, G-AiOV, and G-AOV. This manual is applicable for the current production revision of the modules.

1 SPECIFICATIONS

1.1 General Specifications

Module size W x D x H	135 x 410 x 135 mm 5.3 x 15.0 x 5.3 in
Module weight	6 kg/ 13 lbs

1.2 Typical Performance

Sampling rate	200 ml/min nominal (180 - 220 ml/min)
Display update rate	breath-by-breath

Automatic compensation for pressure, CO_2-N_2O, and CO_2-O_2 collision broadening effect.
Warm-up time 3 min for operation, 30 min for full specifications.

Auto-zeroing is performed at start-up, after 5 min, 5 min., 5 min., 15 min., 15min., 15 min., and after that at 60 min. regular intervals.

CO_2

Measurement range	0 to 10 %, (0 to 10 kPa), (0 to 76 mmHg)
Extended range	10 to 15 %, (10 to 15 kPa), (76 to 114 mmHg)

If CO_2 concentration is below 0.1 %, 0.0 % is displayed.

RESPIRATION RATE

Breath detection	1 % change in CO_2 level
Measurement range	4 to 60 breaths/min

O_2

Measurement range	0 to 100 % O_2

N_2O

Measurement range	0 to 100 % N_2O

HAL, ISO, ENF

Measurement range	0 to 5 %
Extended range	5 to 15 % (unspecified)

SEV

Measurement range	0 to 8 %
Extended range	8 to 15 % (unspecified)

DES

Measurement range	0 to 18 %
Extended range	18 to 25 % (unspecified)

Resolution	two decimals when the AA concentration below 1.0 %

If AA concentration is below 0.10 %, 0.00 % is displayed.

AGENT IDENTIFICATION

Identified agents	HAL, ENF, ISO, SEV, DES
Identification time	30 seconds (typical value with pure agents)
Identification treshold	0.15 vol% (typical)

Mixture warning when minor component concentration > 0.3 vol% and >15 %of total agent concentration

SIDE STREAM SPIROMETRY

Values are valid when:

Respiratory rate	adult 4..30	pedi 4..50

I:E ratio is 1:3 - 1:0.5

Inner diameter of ET tube is $\geq$5.5 mm (adult) or 3 to 6 mm (paediatric).

Airway Pressure (Paw)

Accuracy	$\pm$1.5 cmH_2O
Resolution	1 cmH_2O
Measuring range	-20 to +80 cmH_2O

Tidal Volume (TV)

Accuracy (paed)	$\pm$6 % or 30 ml (adult); $\pm$6 % or 4 ml
Resolution	1 ml
Measurement range	150 to 2000 ml (adult) 15 to 300 ml (paed)

Minute Volume (MV)

Resolution	0.1 l/min
Measurement range	2 to 15 l/min (adult)
	0.5 to 5 l/min (paed)

Flow

Measurement range (adult)	1.5 to 100 l/min for both directions
(paed)	0.25 to 25 l/min for both directions

1.3 Technical Specification

CO_2

Measurement rise time	<360 ms (from 10 to 90 %)
Gain stability	<=0.2 %CO_2/24 h (0 to 8 %)
	<=0.4 %CO_2/24 h (8 to 10 %)
Gain temperature drift	<=0.2 %CO_2/10°C (0 to 8 %)
	<=0.4 %CO_2/10°C (8 to 10 %)
Nonlinearity error	<=0.2 %CO_2 (0 to 8 %)
	<=0.4 %CO_2 (8 to 10 %)

O_2

Measurement rise time	<480 ms (from 10 to 90 %)
Gain drift	<=2 % O_2/24 h
Gain temperature drift	<=3 % O_2/10°C
Nonlinearity error	<=2 % O_2

N_2O

Measurement rise time	<360 ms (from 10 to 90 %)
Gain temperature drift	<=3 % N_2O/10°C
Gain drift	<=2 % N_2O/24 h
Nonlinearity error	<=2 % N_2O

AA

Measurement rise time	<520 ms (from 10 to 90 %)
Gain drift	<=0.4 % AA/24 h
Gain temperature drift	<=0.4 % AA/10°C
Nonlinearity error	<=0.2 % AA

Protection against electrical shock Type BF

2 FUNCTIONAL DESCRIPTION

2.1 Measurement Principle

2.1.1 $CO_2/N_2O/AA$ Measurement

The CO_2, N_2O, and anaesthetic agent gas measurements are based on absorption of infrared light as it passes through the gas sample in measuring chamber in the photometer. The light absorption is measured at three wavelengths using an infrared detector. One of the wavelengths is that of the CO_2 absorption peak at 4.3 micrometers, the second is that of the N_2O absorption peak at 3.9 micrometers, and the third is that of the anaesthetic agent absorption peak at 3.3 micrometers. The signal processing electronics receive the signals from the IR detector and demodulate it to get DC components out of these signals which correspond to the content of each gas in the sample.

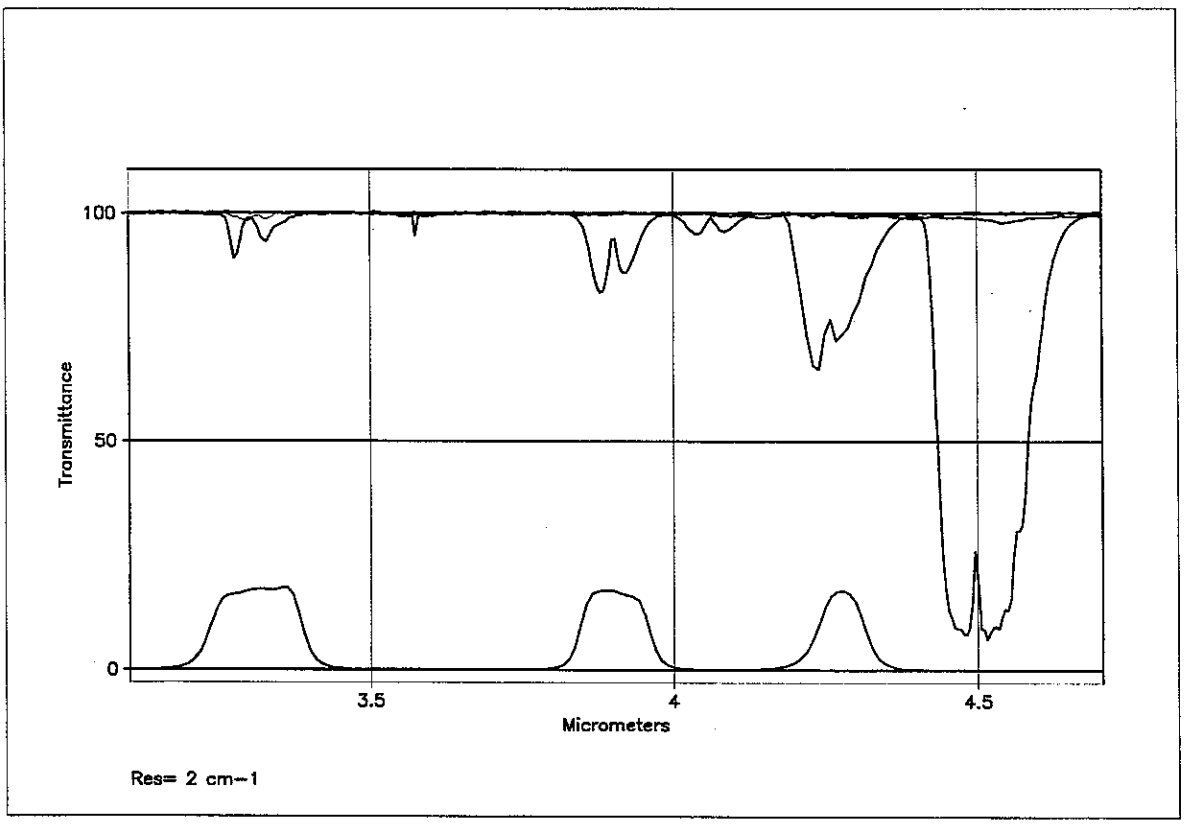


Figure 1 $CO_2/N_2O/AA$ Gas Absorption Spectra

2.1.2. O_2 Measurement

The differential oxygen measuring unit uses the paramagnetic principle in a pneumatic bridge configuration. The signal picked up with a differential pressure transducer is generated in a measuring cell with a strong magnetic field that is switched on and off at a frequency of 110Hz. The output signal is a DC voltage proportional to the O_2 concentration difference between the two gases to be measured.

2.1.3 Agent Identification

The anaesthetic agent identification bench identifies Halothane, Enflurane, Isoflurane, Desflurane and Sevoflurane.

The bench measures the spectrum of the gas between 3.24 µm and 3.39 µm. Because the spectrum of each of the anaesthetic agents is different it is possible to identify them.

The bench consists of an infrared source, a measuring chamber, a rotating filter and a detector. The peak wavelength of the narrow bandpass filter changes when the angle between the light path and the filter is changed. When the filter rotates the required spectrum is scanned through. The agent or a mixture of agents is identified by comparing the measured spectrum with stored reference spectra.

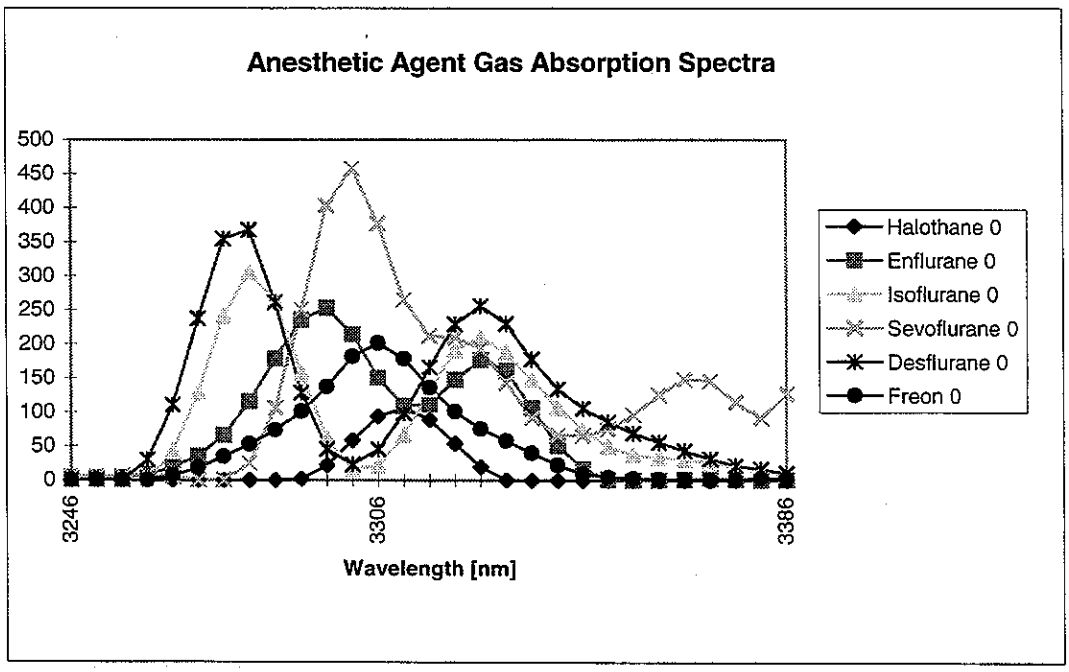


Figure 2 Anaesthetic Agents Gas Absorption Spectra

2.1.4 Side Stream Spirometry

In anaesthesia, CMV (Controlled Mechanical Ventilation) is the mostly used ventilation mode. In this mode, mechanical breaths are delivered to the patient by a ventilator with a proper tidal volume (TV), respiration rate (RR), and inspiration/expiration ratio in time (I:E) determined by the settings of the ventilator.

Delivery of life support gases is based on pressure. However, without knowing volume measured of exhalation, one cannot be sure that a breath occurred. The ultimate goal of ventilation is to use the least amount of pressure to generate the most appropriate volume for each breath.

The Side Stream Spirometry monitors ventilation in anaesthesia. Both patient breathing circuit and the function of the ventilator are monitored. The following parameters are displayed:

Expiratory and inspiratory tidal volume (TV) in ml.
Expiratory and inspiratory minute volume (MV) in l/min.
Expiratory volume in first second (V1.0) in per cent for adults and in 0.5 seconds for children.
Inspiration/expiration ratio in time (I:E)
Airway pressures: Peak pressure (P_{peak}), End inspiratory pressure (P_{plat}), Positive end expiratory pressure (PEEP), Real time airway pressure waveform (P_{aw})
Flow: Real time flow waveform (V')
Compliance (C)
Pressure volume loop
Flow volume loop

Airway pressure

PEEP, P_{peak}, and P_{plat} are measured by pressure transducer on the PVX board. Atmospheric pressure is used as a reference in measurement. The pressure measurement is made from the airway part that is closest to the patient between patient circuit and intubation tube.

Airway flow

The measurement is based on measuring the kinetic gas pressure and is performed using Pitot effect. Pressure

transducer is used to measure the Pitot pressure. The obtained pressure signal is linearized and corrected according to the density of the gas. Speed of the flow is calculated from these pressure values and TV value is then integrated. MV value is further calculated and averaged using TV and RR (respiratory rate) values.

Side Stream Spirometry Sensor

Side stream spirometry is measured with a specific sensor, D-lite or Pedi-lite. For more information about available sensors, please refer to Datex AS/3 Supplies and Accessories Catalogue.

D-lite and Pedi-lite sensors are designed to measure kinetic pressure by two-sided Pitot tube. The pressure reduction caused by measuring cross is taken into account, too, especially in small flows.

Velocity is calculated from pressure difference according to Bernoulli's law. Flow is then determined using the calculated Velocity.

$v = 2 \times dP / \rho$ (Bernoulli's law)

$F = v \times A$

where,
- F = flow (l/min)
- v = velocity (m/s)
- A = cross area (m^2)
- dP = pressure difference (cmH_2O)
- ρ = density (kg/m^3)

Finally the volume information is obtained by integrating the flow signal.

2.2 Main Components and Block Diagrams

2.2.1 In General

The AS/3 Airway Module contains ACX-200 and OM-101 gas measuring units, ASX-200 agent identification unit (i models), PVX board for measuring airway volume and pressure (V models), tubings, sampling pump, ACX Measuring board and Gas mother board.

The gas sampling system samples the measured air to the module, and removes water and impurities from it. A sampling line is connected to the water trap on the front panel. The pump draws gas through the sampling line to gas measuring units. After the measurements, the gas is exhausted from sample gas out connector on the rear panel of the module.

When Side Stream Spirometry is used, special sensors, D-lite or Pedi-lite, replaces the normal airway adapter in the patient circuit. The spirometry tubing is attached to the two connectors on the sensor and on the module front panel.

The Gas mother board processor controls the module functions, such as power supply to each measuring unit, serial communication between module processor, and ACX Measuring board. There are connectors for the pump, valves, and gas measuring units on the board.

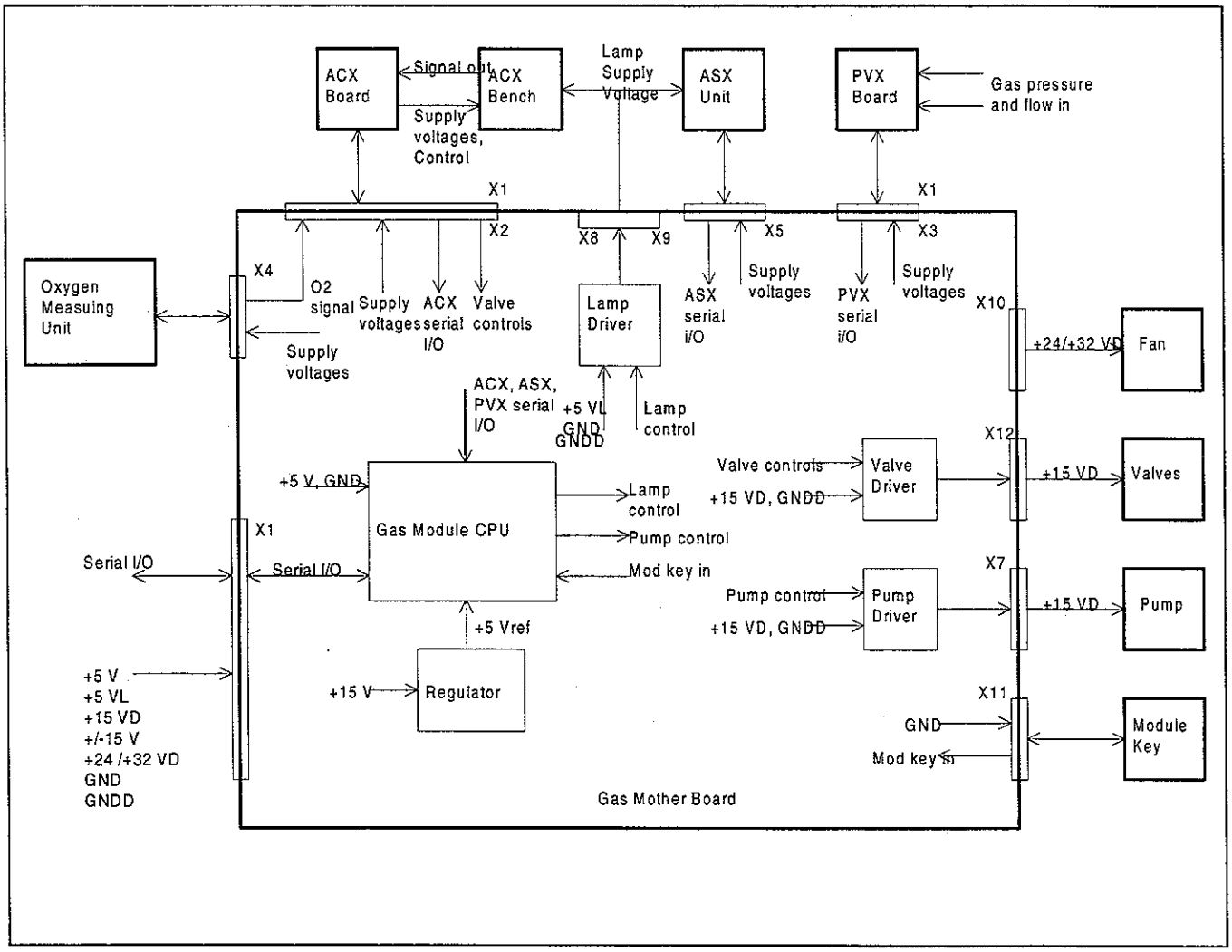


Figure 3 Airway Module Block Diagram

2.2.2 Gas Sampling System

The function of the gas sampling system is to draw sample gas into the monitor gas sensors at a fixed rate and to separate impurities and condensed water from the gas flow.

Water trap

The gas sample enters the monitor through the water trap, where it is divided into two flows, main flow and side flow (see Gas Sampling System Block Diagram). The main flow goes into the measuring system through a hydrophobic filter.

The side flow creates a slight sub-atmospheric pressure within the water trap container. This facilitates cathering the fluid removed by the hydrophobic filter.

Sampling line

The sampling line is an integral part of the total sampling system. The resistance established by the sampling line is significant when the software determines the occlusion and air-leak alarm limits during the turn-on sequence.

The small inner diameter causes fluids such as blood or mucus not to propagate within the tube, so that when the line is clogged, it is replaced.

The Nafion™ tube

A special tube (tubes A or B, and C: see Figure 7) is used to balance the sample gas humidity with that of ambient air. The tube will prevent errors caused by the effect of water vapor on gas partial pressure when humid gases are measured after calibration with dry gases. It is inserted between the water trap and the zero valve (models with i) or between the zero valve and ACX-200 measuring unit (models without i). The tube is also inserted between the CO_2 absorber and the zero valve.

Nafion is a trade mark of Du Pont.

Zero valve

The main flow passes through a solenoid valve before proceeding to the ACX-200 measuring unit. This valve is activated to establish the zero points for the ACX-200 and O_2 measuring units at start-up, at 5 minutes, and after that at regular intervals. After 1-hour monitoring, the auto-zeroing is performed once an hour. When the valve is activated, room air is drawn through the CO_2 absorber into the internal system and the gas sensors.

Gas measuring units

After the zero valve, the gas passes through the ACX-200 and O_2 measuring units. In the ACX-200 measuring unit, infrared light is passed through chambers containing the main flow gas (measurement) and a chamber containing reference gas. The measurement is made by determining the ratio between the two light intensities.

The oxygen sensor has two inputs. One input accepts the main flow and the other draws in room air for reference. The sensor uses a differential pressure transducer to compare the pressure gradient produced when both gases are exposed to an oscillating magnetic field. Both gas flows exit from a single port.

In i model, the ASX agent identification unit is installed in parallel with the oxygen sensor. The task of the ASX unit is to identify anaesthesia agents by infrared light method used also in the ACX-200 unit.

Pressure valve

The pressure valve is used to measure the pressure gradient between the O_2 measurement flow and the O_2 reference flow. This pressure gradient reflects the condition of the D-fend water trap filter.

Normally the pressure gradient between the O_2 measurement flow and the reference flow is approximately +8 mmHg. If the software detects the gradient to be between 0 and -5 mmHg, the pressure valve will initiate pressure measurement of the reference flow. If the gradient is greater than -5 mmHg, the software triggers the message "REPLACE TRAP".

Flow cassettes

The internal flow rates are set using flow cassettes. These cassettes are used to set the side flow rate and the O_2 reference flow rate, the flow rates through the measuring units and the total flow rate of the sampling system.

Sampling pump and damping chamber

The sampling pump is a vibrating membrane pump driven by a 50 Hz/12 V/0.4 A square wave current.

The damping chamber is used to even out the pulsating flow and silence the exhaust flow.

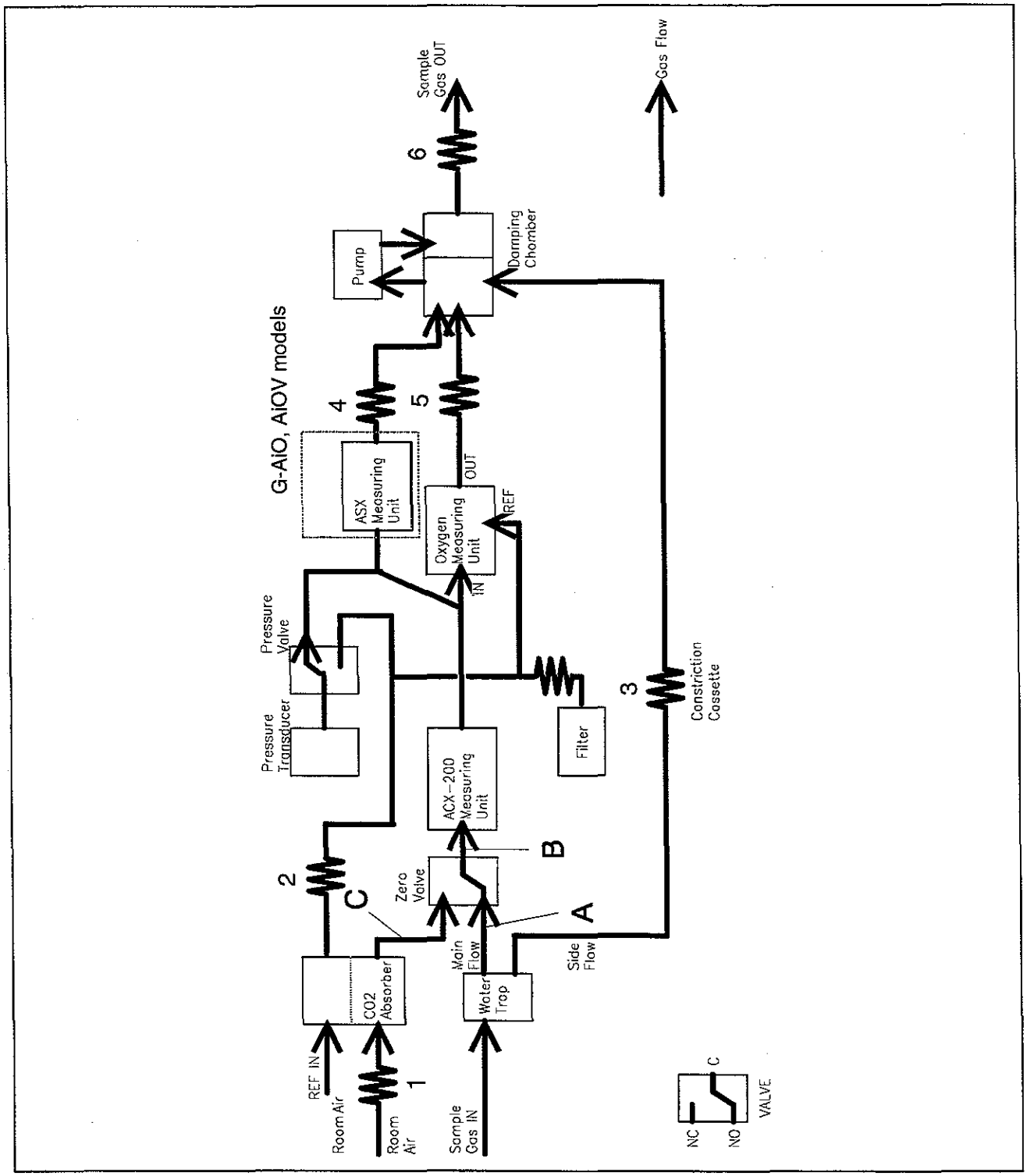


Figure 4 **Gas Sampling System Block Diagram**
In G-AO, AOV models, tube A is Teflon, B and C Nafion.
In G-AiO, AiOV models, tubes A and C are Nafion, B is Teflon.

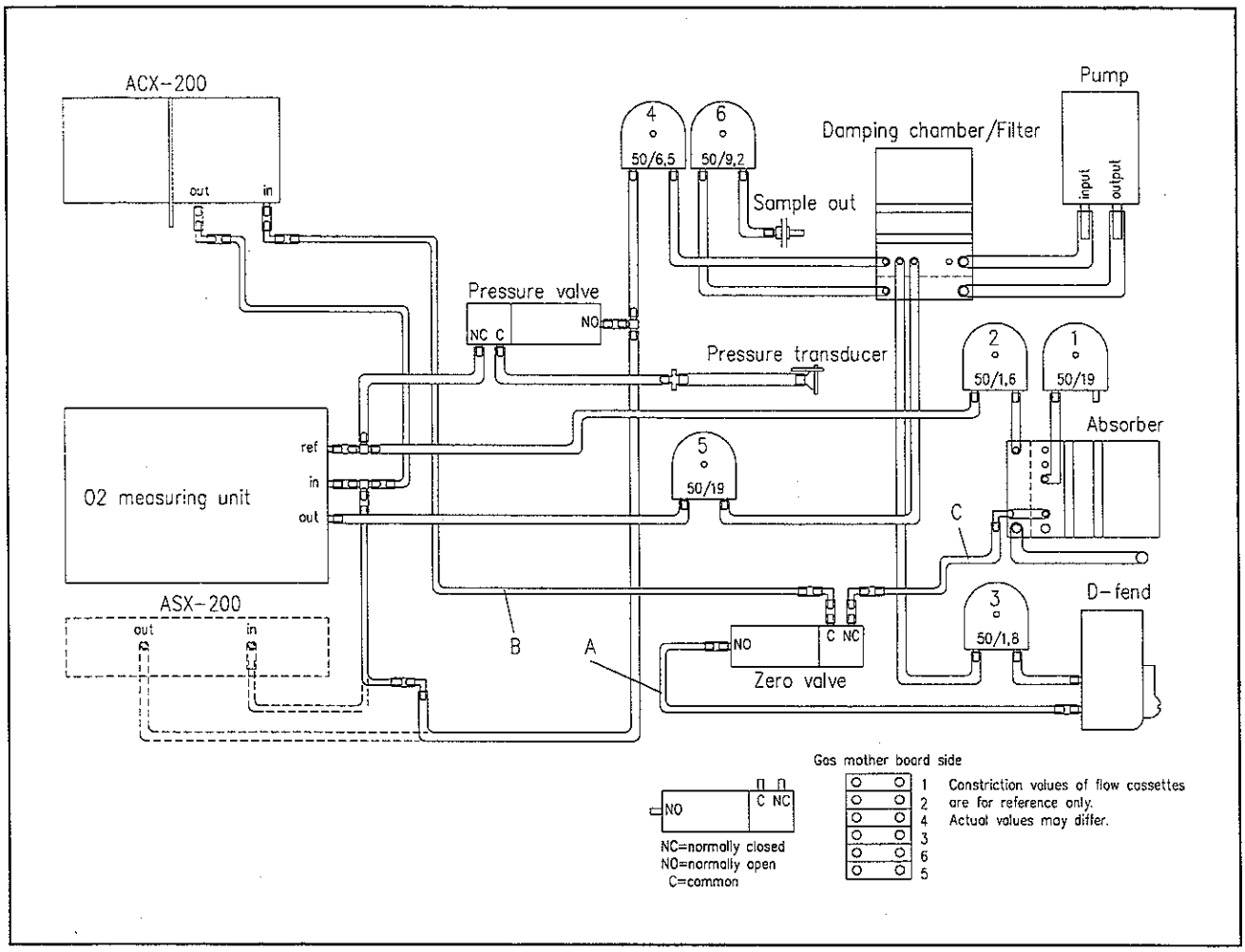


Figure 5 Gas Sampling System Layout

Table 1 Flow Cassettes

FLOW CASSETTE	CODE
50/26.0	878048
50/19.0	873800
50/16.3	878047
50/15.3	873801
50/14.1	878046
50/13.1	873802
50/12.4	878045
50/11.2	874770
50/10.4	873803
50/9.2	874509
50/8.7	873804
50/7.4	873805
50/6.5	878044
50/5.8	873806
50/5.1	878043
50/4.4	873807
50/3.8	878042
50/3.2	873808
50/3.0	878040
50/2.8	878039
50/2.5	878038
50/2.3	873809
50/2.0	878037
50/1.8	873810
50/1.6	878036
50/1.4	873811
50/1.1	873812

NOTE: The number on the cassette represents relative flow when a specific pressure is applied. Therefore 50/26.0 presents the least resistance and 50/1.1 the most.

2.2.3 ACX-200 Measuring Unit

CAUTION: The ACX-200 photometer and its components are repaired/calibrated at the factory. Attempts to repair/calibrate the unit elsewhere will adversely affect operation of the unit. Datex supplies spare ACX-200 photometers. The information provided for the ACX-200 is for reference only.

The ACX photometer is of dual path type. The infrared light beam passes through a measuring chamber containing the gas to be analyzed, and a reference chamber, which is free of CO_2, N_2O, and AA. The measurement is made by determining the ratio between the two light intensities.

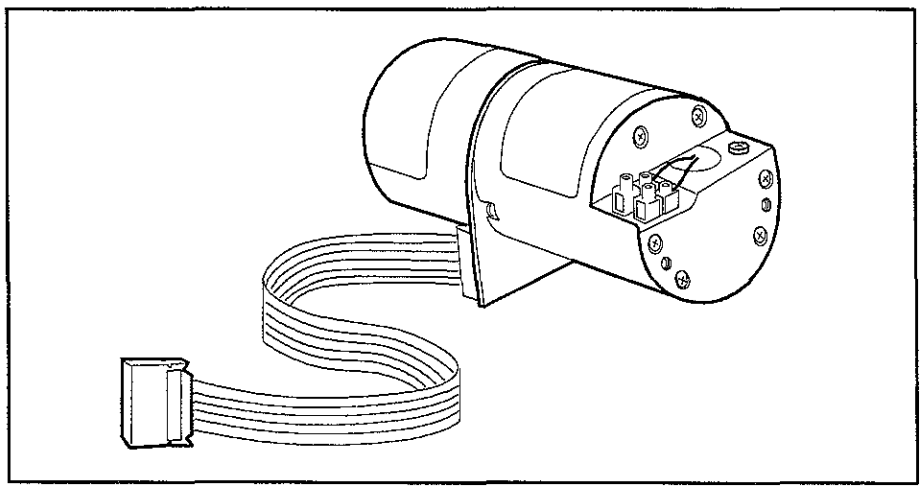


Figure 6 ACX Photometer (ACX-200 Measuring Unit)

A filter wheel is used to control the light from an incandescent lamp that passes through the photometer. The filters are arranged so that the light is passed sequentially:

- first at the CO_2 absorption wavelength through the reference chamber
- then through the measuring chamber
- finally it is blocked completely

The same sequence is repeated at the N_2O and anaesthetic agent gas absorption wavelengths.

After passing through the filters the light is reflected and focused by a mirror onto the infrared detector. This detector measures the three light levels for each gas described above.

There is an optical sensor incorporated in the photometer which detects light from a reflective surface on the filter wheel once every revolution. The pulses from this sensor are used to synchronize the electronics to the signal from the infrared detector. A stabilizing diode measures the temperature, which is needed to compensate for thermal drifts. The infrared detector, the optical sensor and the stabilizing diode are mounted on the preamplifier board.

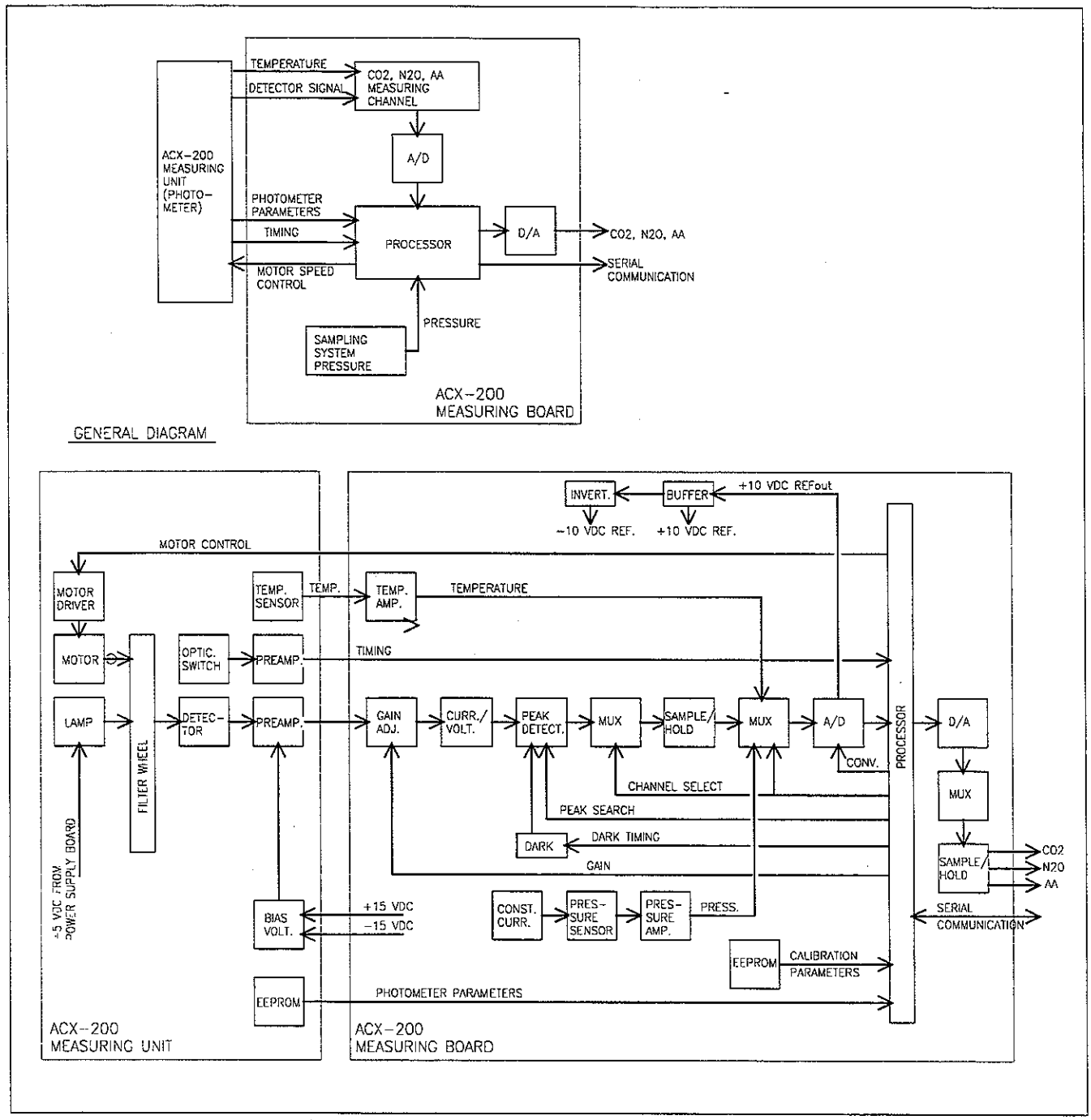


Figure 7 $CO_2/N_2O/AA$ Measurement Block Diagram

2.2.4 O_2 Measurement

The oxygen measurement is based on the paramagnetic susceptibility, which is a unique property of oxygen among all gases generally present in a breathing gas mixture. The gas to be measured and the reference gas, which usually is room air, are conducted into a gap in an electromagnet with a strong magnetic field switched on and off at a frequency of approximately 110 Hz.

An alternating differential pressure is generated between the sample and reference inputs due to forces acting to the oxygen molecules in a magnetic field gradient.

The pressure is measured with a sensitive differential transducer, rectified with a synchronous detector and amplified to produce a DC voltage proportional to the oxygen partial pressure difference of the two gases.

CAUTION: Due to the complicated and sensitive mechanical construction any service inside the O_2 measuring unit should not be attempted.

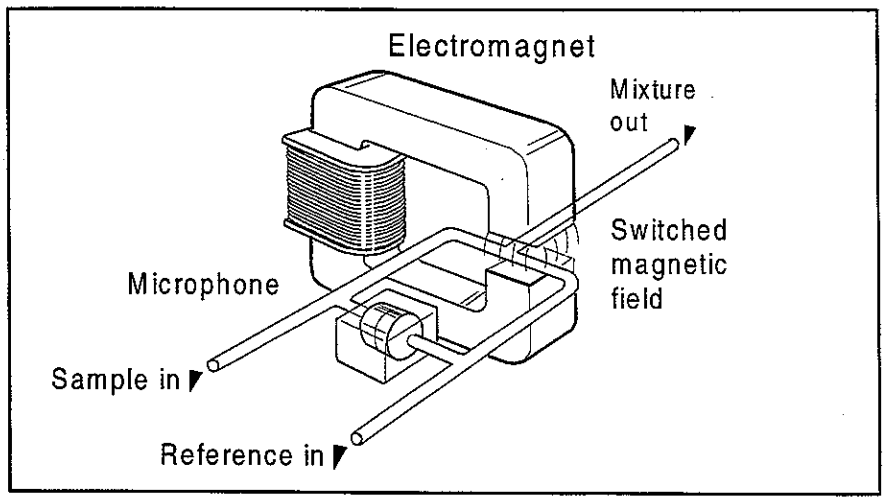


Figure 8 O_2 Measurement Principle

2.2.5 ACX Measuring Board

The measuring electronics can be divided into a few functional blocks, which are described below (See the block diagram in Figure 9).

CAUTION: The ACX-200 Measuring board can be repaired and calibrated only at the factory.

The ACX Measuring board controls gas measurements. It converts the photometer signal into digital data, calculates results and transmits it to Gas mother board. The board contains, in addition to the 80C51FA processor, EPROM, RAM, and EEPROM, several analog and digital I/O functions.

Internal and external bus

The processor has access to the Measuring board peripherals (memory, A/D converter, D/A converters, etc) via an internal bus. For communication between the Gas mother board and the Measuring board, there is an external bus in connector X1.

Memory

Memory components include 64k x 8 bit program memory EPROM, 32k x 8 bit low current CMOS RAM powered by a data retention voltage generation circuit in Power supply board, and EEPROM for permanent calibration values and setup memory.

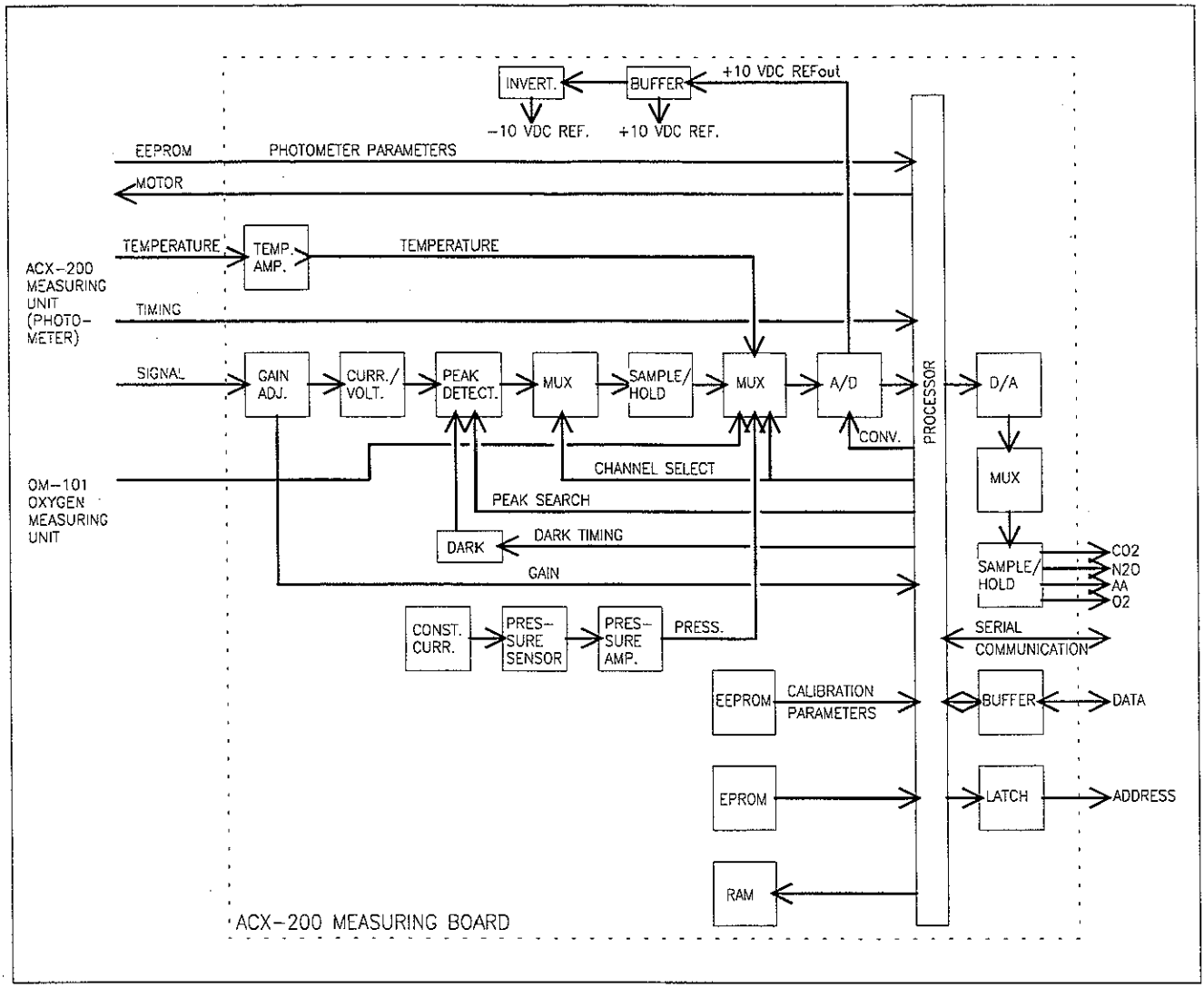


Figure 9 ACX Measuring Board Block Diagram

2.2.6 ASX Agent Identification Bench

The ASX-200 agent identification bench has one measuring chamber. Background compensation is done by subtracting the background spectrum from the measured signal. Background spectrum is measured simultaneously with the zeroing of the ACX-200 unit. The resulting spectrum is analyzed to identify the agent.

The ASX unit requires two calibrations. One is the time between synchronization pulse and measured spectrum (time offset) of the ASX-200 and the other is the peak wavelength of the narrow bandpass filter. The former is calibrated automatically together with the gas calibration of the ACX and the latter is calibrated at the factory.

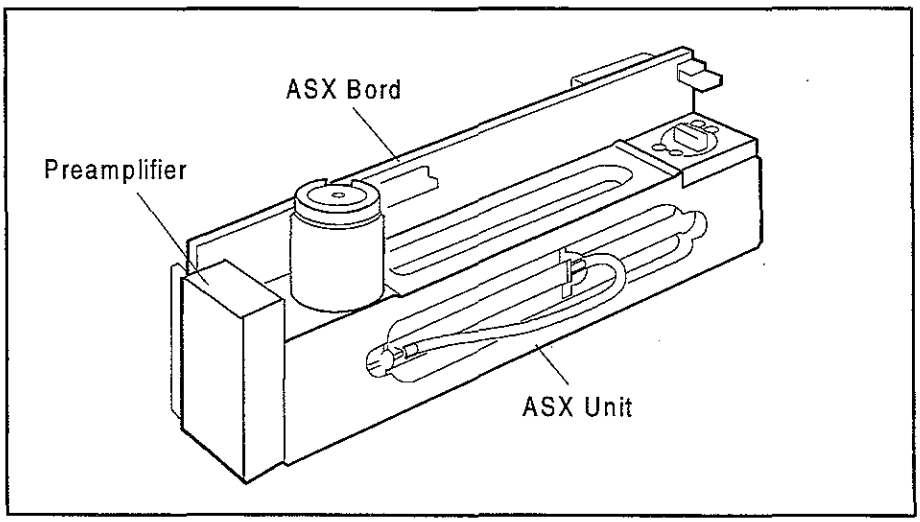


Figure 10 ASX Measuring Unit

ASX Preamplifier Board

The absorption of infrared light is measured with a lead selenide detector. The signal is amplified and then led to the measuring board.

2.2.7 ASX Measuring Board

The measuring electronics can be divided into a few functional blocks, which are described below (See the block diagram in Figure 11).

The ASX measuring board controls the measurement. It converts the ASX photometer signal to digital data, calculates results and communicates with the main CPU through a serial channel. The board contains, in addition to the 80C196 processor, EPROM, RAM, and EEPROM, several analog and digital I/O functions.

Processor section

Processor is a 80C196 and works at 12 MHz. It has an internal A/D-converter with a multiplexer. One channel is used for converting temperature signal. Two others are for the measurement signal from preamplifier board.

The processor uses an internal bus to access EPROM (64k x 8 bit), SRAM (8k x 8 bit) and two D/A-converters. It communicates with the Gas mother board through a serial channel (RXD, TXDB).

EEPROM is a 64 x 16 bit serial chip. It is partly protected so that if jumper X1 is installed the processor can erase or write the protected registers by serial communication commands. The protected section contains permanent factory calibrations.

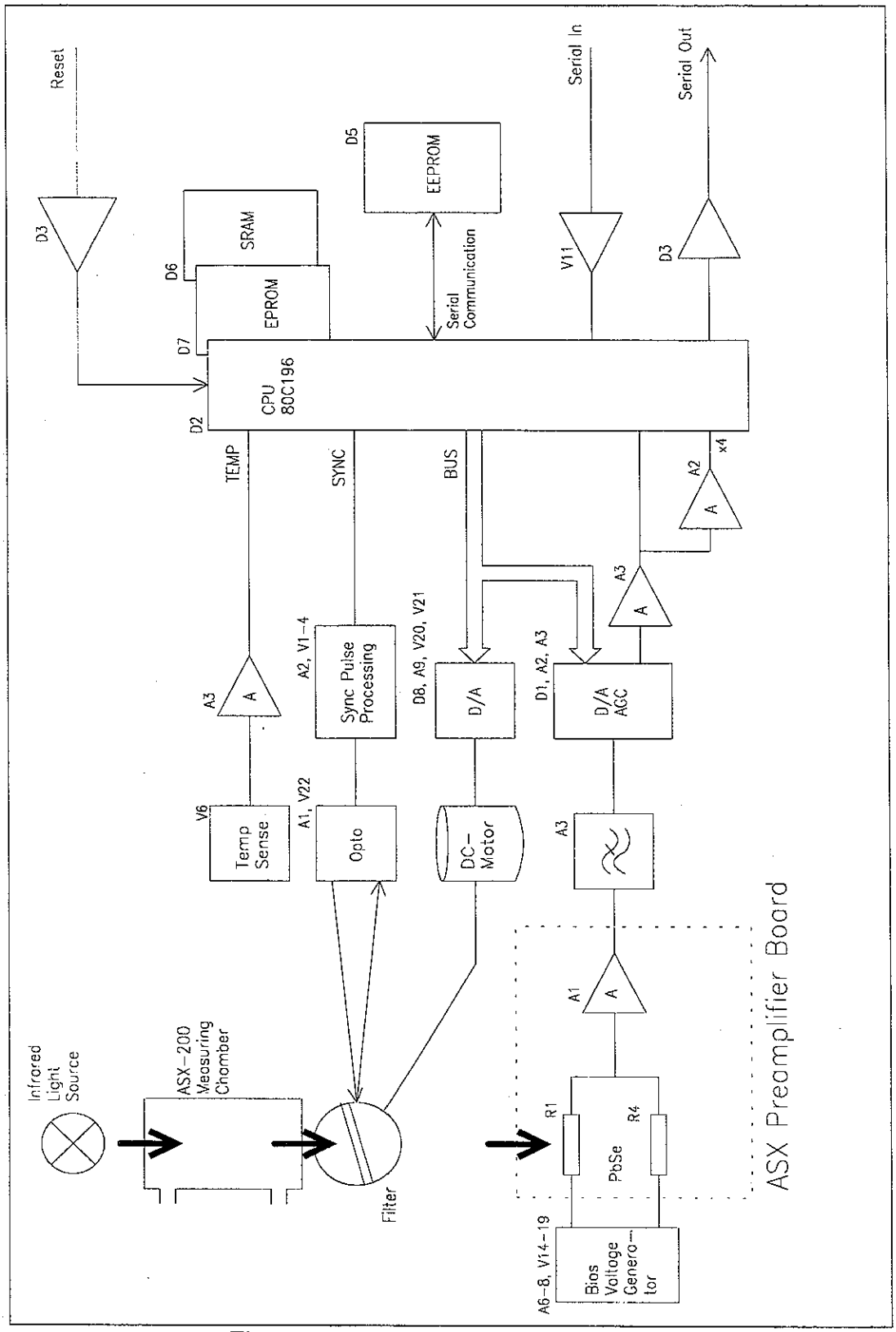


Figure 11 ASX Measuring Board Block Diagram

2.2.8 PVX Board

CAUTION: The PVX-100 measuring unit can be repaired only at the factory.

NOTE: Overpressure or negative pressure of more than 300 cmH_2O to the flow and volume tubing should never be applied.

The board is intended to perform the following tasks

- Measure the pressures in airways and the speed of breathing flow.
- Calculate tidal volume, minute volume, compliance and other useful information on patient lungs.

Pressure transducers

There are two pressure transducers on the PVX board for airway pressure measuring purposes.

The breathing flow of a patient passing through D-lite adapter creates pressure difference. This pressure difference is measured by pressure transducer, B1. Overpressure and negative pressure in airways are measured by another pressure transducer B2.

NOTE: Never apply DIFFERENTIAL pressure higher than 25 cmH_2O to the spirometry tubing. Make sure that both spirometry tubes are always connected.

Temperature compensation

Temperature is measured by B1. This signal is used only for temperature compensation of the pressure transducer B1 on the PVX board.

Data processing

After the multiplexer, the signals, PRESS, FLOW0, FLOW1, and TEMP are A/D converted for data processing.

External communication

Communication between the PVX board and the Gas mother board is established in serial form, using the serial channel (pins 10 and 11) of CPU on the PVX board.

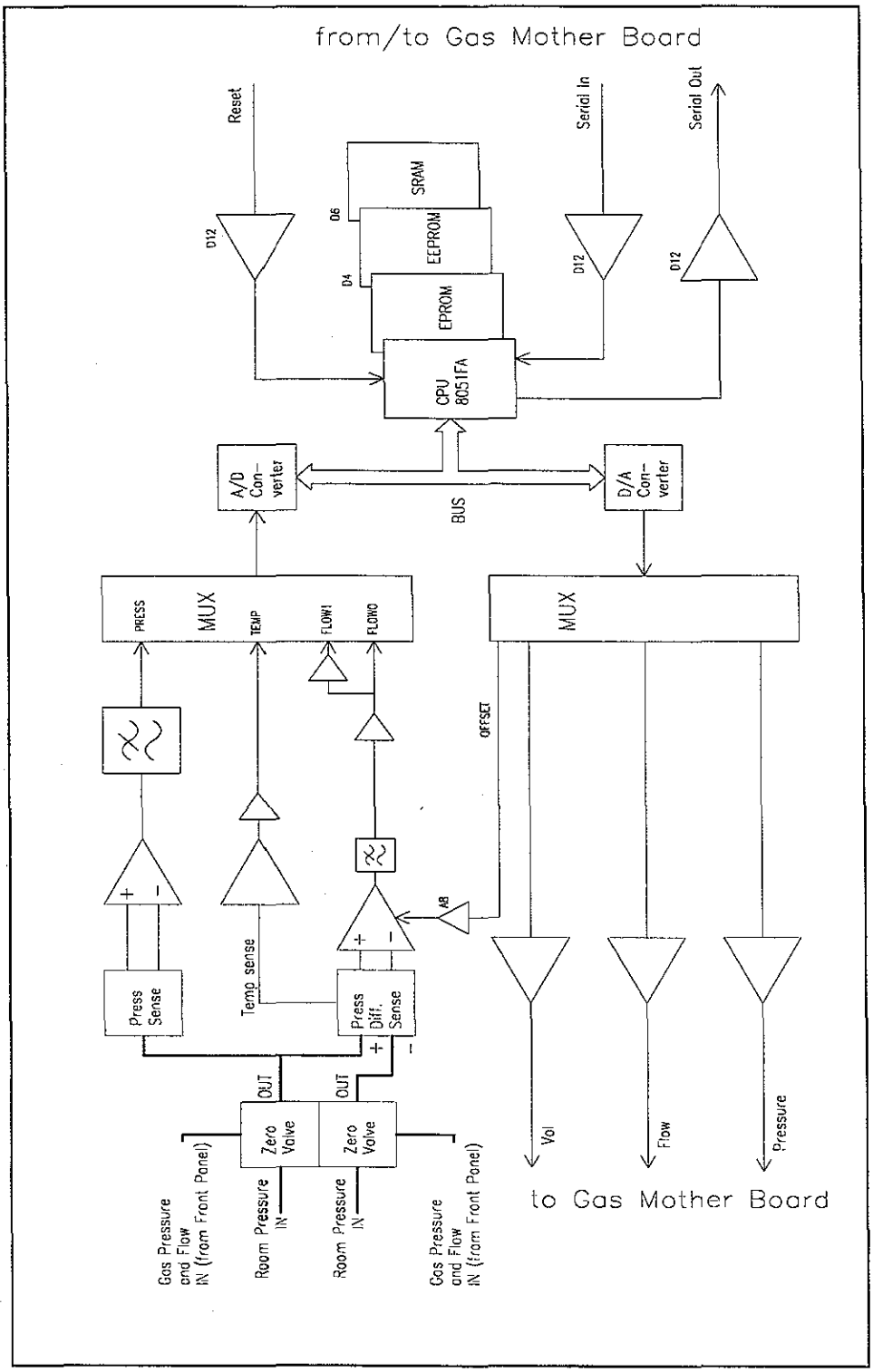


Figure 12 PVX board block diagram

2.2.9 Gas Mother Board

The Gas mother board controls power supply to each measuring unit, as well as the serial communication between the units and the module processor. There are connectors for the pump, valves and gas measuring units on the board. The board contains a processor which controls the functions within the module.

The tasks of the module processor are:

- to receive commands from the main CPU board and pass them on to Measuring boards.
- to gather measurement results from the Measuring boards, analyze them, and transmits data to the main CPU board.
- to control the valves and pump based on the data which ACX Measuring board transmits.

Main parts

- Module processor 80C196KC/16 MHz.
- 16 MHz oscillator.
- EPROM program memory.
- External RAM memory
- EEPROM.
- Address and data bus latch.
- Address decoding GAL-circuit.
- 4-channel serial communication IC (QUART, D4).

External communication

Serial communication bus inside the module processor is used. The bus is connected to module bus via RS-485 buffer. Transmit and reception controls of buffer are controlled by the processor.

Connections to Measuring boards

Data collection from the measuring units takes place in serial communication bus. Serial communication lines of the measuring units are connected to QUART IC on the Gas mother board; Channel 1 - ACX, channel 2 - ASX, channels 3 - PVX, channel 4 - not in use). The transmit side of QUART has a buffer IC and the receipt side has a pull-up resistor.

Valves, pump, and infrared lamps control

Valves are controlled by ACX Measuring board from which the control signals are ran through buffer IC to the valve connector. OCCLUS signal controls the pressure (occlusion) valve and ZERO signal controls the zero valve.

Control signal for the pump comes from the module processor. The signal is 50 Hz pulse-width modulated square wave. Control command is received from ACX Measuring board in serial communication.

Control command (LAMP) of the infrared lamps of the chambers comes from the module processor.

Key push reading

CPU reads the front panel key pushes.

Reset

Voltage supervising circuit performs power-on reset. Reset from the module bus is connected via RS-485 buffer.

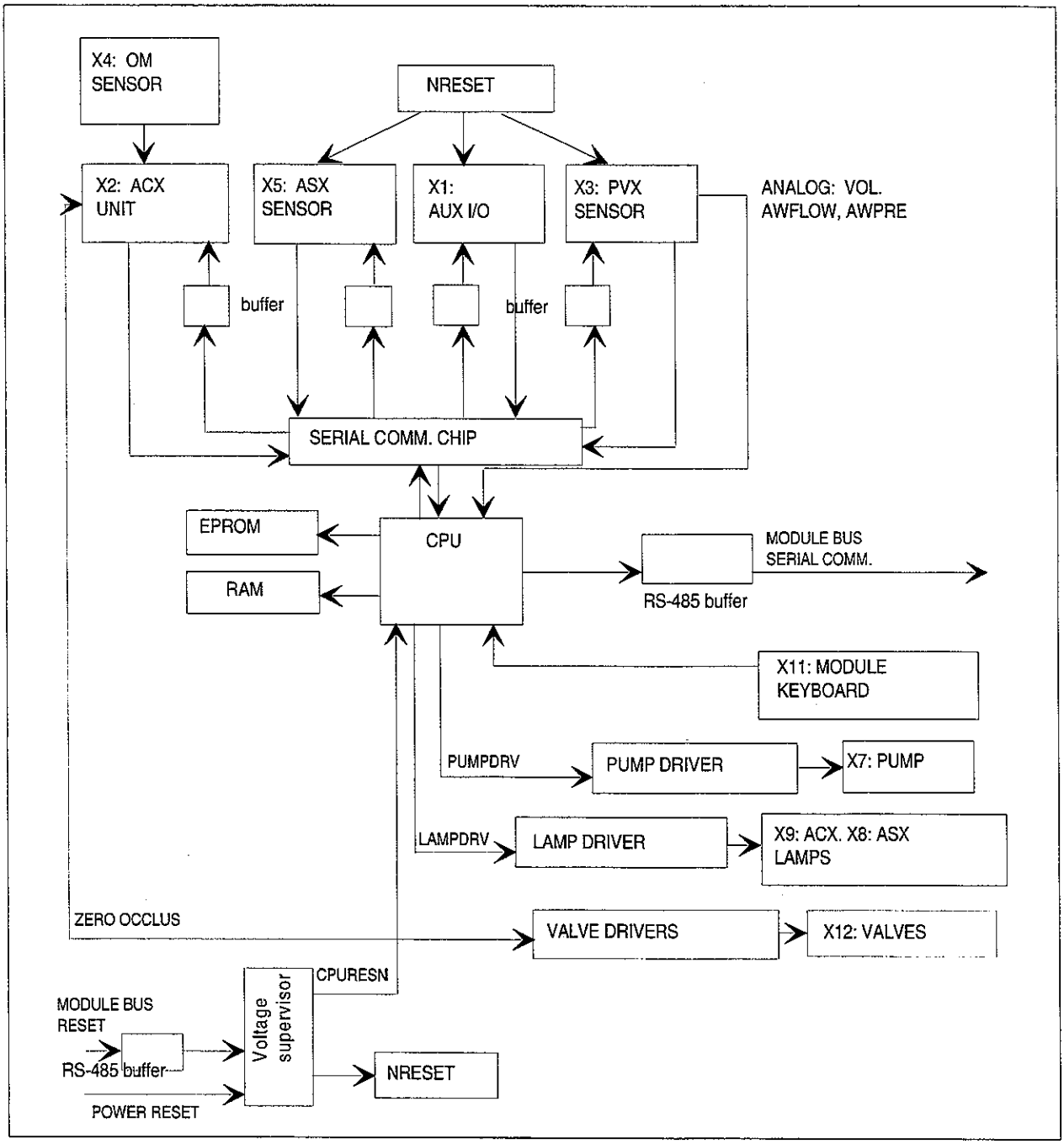


Figure 13 Gas Mother Board Block Diagram

2.2.10 Gas Interface Board

The Gas Interface Board, B-GAS is used for connecting an Airway Module to the Central Unit.

The board connects Airway Module signals to the module bus and supplies voltages from the module bus to the Airway Module.

On the board there is a fuse (T4A) and some capacitors to regulate the power supply.

2.3 Connectors and Signals

Module Bus Connector Configuration

Module Rear Panel 25-Pin Male D-Connector and B-GAS Board Rear Panel Female D-Connector

Pin No	I/O	Signal	Notes
1	I	RESET_RS485	
2	I	-15 VDC	
3	I	+15 VDIRTY	
4	I	+15 VDC	
5	I/O	-DATA_RS485	
6	I/O	DATA_RS485	
7		Ground & Shield	
8	I	-RESET_RS485	
9		n/c	
10		n/c	
11		n/c	
12		n/c	
13		Ground & Shield	
14	I	+24/+32 VDIRTY	Depends on power supply
15	I	GroundDIRTY	
16		n/c	
17		n/c	
18		n/c	
19		n/c	
20	I	GASFR	For factory use only
21	I	CTSD	For factory use only
22	I	TXDD	For factory use only
23	O	RXDD	For factory use only
24	I	+5 VDC	
25	I	+5 VDC DIRTY	for infrared lamps

For B-GAS CPU Mother Board connector, see CPU Bus Connector in the Central Unit Section.

Gas Mother Board Connectors

X1 Module connector. Serial communication bus to the main CPU board. Supply voltages.

X2 ACX Measuring board.

X3 PVX board.

X4 Oxygen measuring unit.

X5 ASX Measuring board.

X7 Sampling pump.

X8, X9 Power supply for infrared lamps (ACX, ASX)

X10 Fan.

X11 Module front panel keys

X12 Valves.

Connector pin configurations

ACX Measuring board (X1) - Gas mother board (X2)

Pin No.	a	b	c
1	+15 V	NC	AGND
2	-15 V	NC	+10 VREF
3	AOUT6	NC	AOUT5 AA
4	AOUT4 VL	NC	AOUT3 CO_2
5	AOUT2 O_2	NC	AOUT1 N_2O
6	DAC1 FLOW	NC	DAC0 PRES
7	AIN7 SAL	NC	ADC6 VOUT R
8	ADC5 AWL	NC	ADC4 VOUT IR
9	ADC3 O_2	NC	ADC2
10	ADC1 AWP	NC	AIN4 SSIGN
11	NC	AGND	NC
12	NC	AGND	NC
13	NC	LAMP	NC
14	NC	PB5	NC
15	NC	SSYNC	NC
16	RBD2	SMOTOR	NC
17	-RESET	-PC0	TO RTSO
18	SEROUT 0	NC	SERIN 0
19	P1.1	PC2 FGAIN 1	P1.0
20	OP0 RTSA	PC3 FGAIN 2	INT0
21	SEROUT 1	PC4 OCCLUS	SERIN 1
22	OP1 RTSB	PC5 PUMPON	IP2 TIMERIN 0
23	SEROUT 2	PC6 ZERO	SERIN 2
24	NC	PC7 RTS0	NC
25	NC	PA0	NC
26	NC	PA1	NC
27	NC	PA2	NC
28	INT1	PA3	INT3
29	+5 V DRV	PA4	+5 V
30	+15 VDIRTY	PA5	+5 V
31	+12 V	PA6	21 VAC
32	GND DIRTY	PA7 ALR CALL	DGND

NC = not connected
AIN is an AD-converter and AOUT is a DA-converter in ACX board.
ADC is an AD-converter and DAC is a DA-converter in the Gas mother board.

ASX board (X5) - Gas mother board (X5)

Pin No.	Signal
1	Analog ground
2	N/C
3	N/C
4	N/C
5	+15 V
6	-15 V
7	DIRB (not used)
8	RXD
9	TXDB
10	N/C
11	-RESET
12	+5 V
13	+15 VDIRTY
14	Digital ground

PVX board (X1) - Gas mother board (X3)

Pin No.	a	b	c
1	+15 V	NC	AGND
2	-15 V	NC	+10 VREF
3	NC	NC	NC
4	NC	NC	NC
5	NC	NC	NC
6	DAC1 FLOWY	NC	DAC0 PRES
7	VOL	NC	NC
8	FLOW	NC	NC
9	NC	NC	NC
10	PRESS	NC	NC
11	NC	NC	NC
12	NC	NC	NC
13	NC	NC	NC
14	NC	NC	NC
15	NC	NC	NC
16	NC	NC	NC
17	-RESET	NC	NC
18	NC	DIR	NC
19	NC	NC	NC
20	NC	NC	NC
21	RxD	NC	TxDP
22	NC	NC	NC
23	NC	NC	NC
24	NC	NC	NC
25	NC	NC	NC
26	NC	NC	NC
27	NC	NC	NC
28	NC	NC	NC
29	NC	NC	+5 V
30	+15 VDIRTY	NC	+5 V
31	NC	NC	NC
32	GND DIRTY	NC	DGND

3 SERVICE PROCEDURES

3.1 General Service Information

Usually field service is limited to replacing the faulty circuit boards or mechanical parts. The boards are then returned to Datex for repair.

Datex is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

CAUTION: Only trained personnel with appropriate equipment shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

NOTE: After any component replacement see Chapters Adjustments and Calibrations.

3.2 Preventive Maintenance

We recommend that you perform these checks after any service and at least once a year to keep the AS/3 Airway Module in good condition.

1. Visual inspection

__: Fan is running and rear panel dust filter is clean (clean it at least once a month).

__: If the module is disassembled, check that grounding wires and all connectors are properly connected and there is no loose object inside the module. Check that no tube is in contact with the sampling pump or oxygen measuring unit. Check also that tubes are not pinched and there is no sharp bend before attaching the module box.

2. Functional checks

Use an original Datex sampling line and clean D-fend water trap. Connect the sampling line to the water trap before switching the power on. Wait five minutes for the Airway module to warm-up.

__: As the sampling line is taking in room air, the numeric display of FIO_2 should be 21 ± 1 after five minutes.

__: Select Enflurane in Agent select menu. Perform gas calibration (see Operator's manual) when at least 10 minutes have passed after the power on. The measured values should be within the tolerance ranges listed below.

Gas	Tolerance range
CO_2	± 0.5 % CO_2 (> 8 % CO_2) or ± 0.4 % CO_2 (< 8 % CO_2)
O_2	± 5 % O_2 (about 100 % O_2)
N_2O	± 5 % N_2O (about 100 % N_2O)
ENFL	± 0.6 %

Press Normal screen key to end calibration.

__: Block the sampling line and make sure that the Occlusion warning comes on after 15 seconds.

__: Remove the water trap and make sure that the Air leak warning comes on after 15 seconds.

__: Perform the sampling system leak test (see chapter 4.2).

__: Check the rates of main flow, side flow, and oxygen measurement reference flow.

__: Perform the water separation test (see chapter 4.2).

Go to Service Menu and ACX Service Menu (see chapter 5).

__: Check the functions of zero and occlusion valves, and pump. Additionally key (button) function in AO and AOV models.

__: Check working pressure (Work press). It should be about 700 mmHg. Check also oxygen measurement pressure difference (OMin-OMref). It should be between 5 to 10 mmHg.

Exit the Service Menu.

__: Perform gas calibration again. The measured values should be within the tolerance ranges listed above. If required, perform the adjustments.

Press Normal screen key to end calibration.

3.3 Disassembly and Reassembly

The Airway module (AiOV model) is disassembled in the following way. See chapter 6.1 for the exploded view of the unit:

a) Remove three screws from the rear panel.

b) Remove one thumb screw and one 5 mm cross recess screw from the bottom of the Airway module case.

c) Slide the case rearward and detach it from the module.

d) Lift off the top protection cover.

Now two pc boards are exposed: PVX board (front) and ACX Measuring board (rear).

The PVX board can be detached by pulling sideways after two tubes are disconnected from two valves.

The ACX Measuring board can be detached by pulling sideways after a ribbon cable connector is disconnected and a tube is pulled off from pressure transducer.

e) Remove the bronze plate from the right side of the module by pulling it up.

f) To remove the Gas mother board cover, remove two front panel screws from the side of the module, and the D-connector screws.

g) The front panel can be detached by removing three screws.

h) Tubing system plate with tubes and flow cassettes can be lifted off.

i) Fan can be lifted off after plastic pc board rail is detached.

Gas mother board is attached to the side of the module with screws.

The ASX unit, the ACX Measuring unit, and the O_2 measuring unit are attached to the chassis with two screws each.

The pump and its magnetic shield can be removed from the chassis by unscrewing the two screws beneath two springs at the port side of the pump.

Damping chamber/filter case can be slided out of hooks.

Reassembling is essentially reversing what was described above.

CAUTION: When reassembling the module, make sure that the tubes and cables are not pinched between the boards and the cover.

3.4 Adjustments and Calibrations

See Operator's manual for normal gas calibration instructions.

3.4.1 Gas Sampling System Adjustment

Flow rates should be measured and possibly adjusted under the following conditions:

- After any part within the sampling system has been replaced
- Gas response is slow

NOTE: Adjust the flows with a new, clean D-fend water trap and original Datex sampling line.

NOTE: Before adjusting the flows, make sure that there is no leakage in the sampling system.

NOTE: Let the monitor warm up for 30 minutes before measuring flow rates.

For the flow rate measurements a flowmeter with a low flow resistance and capability to measure low flow rates is required. A normal length of sampling line has to be connected to the monitor as it has a considerable effect on the flow.

The flow rates are adjusted by changing the flow resistance cassettes (constriction cassettes) in the sampling system. See Table 1 in chapter Gas Sampling System for the alternative cassettes.

The adjustments and the respective constrictions to be adjusted are shown in the next figure.

Flow Rate

If any flow rates are not correct, first replace the D-fend water trap. Then recheck the incorrect flows before adjusting the flow rates.

The sampling flow rate is measured by a flowmeter at the sampling line. The rate should be between 180 and 220 ml/min.

The flow rate is adjusted by changing the flow cassette which is located behind the pump (no. 6).

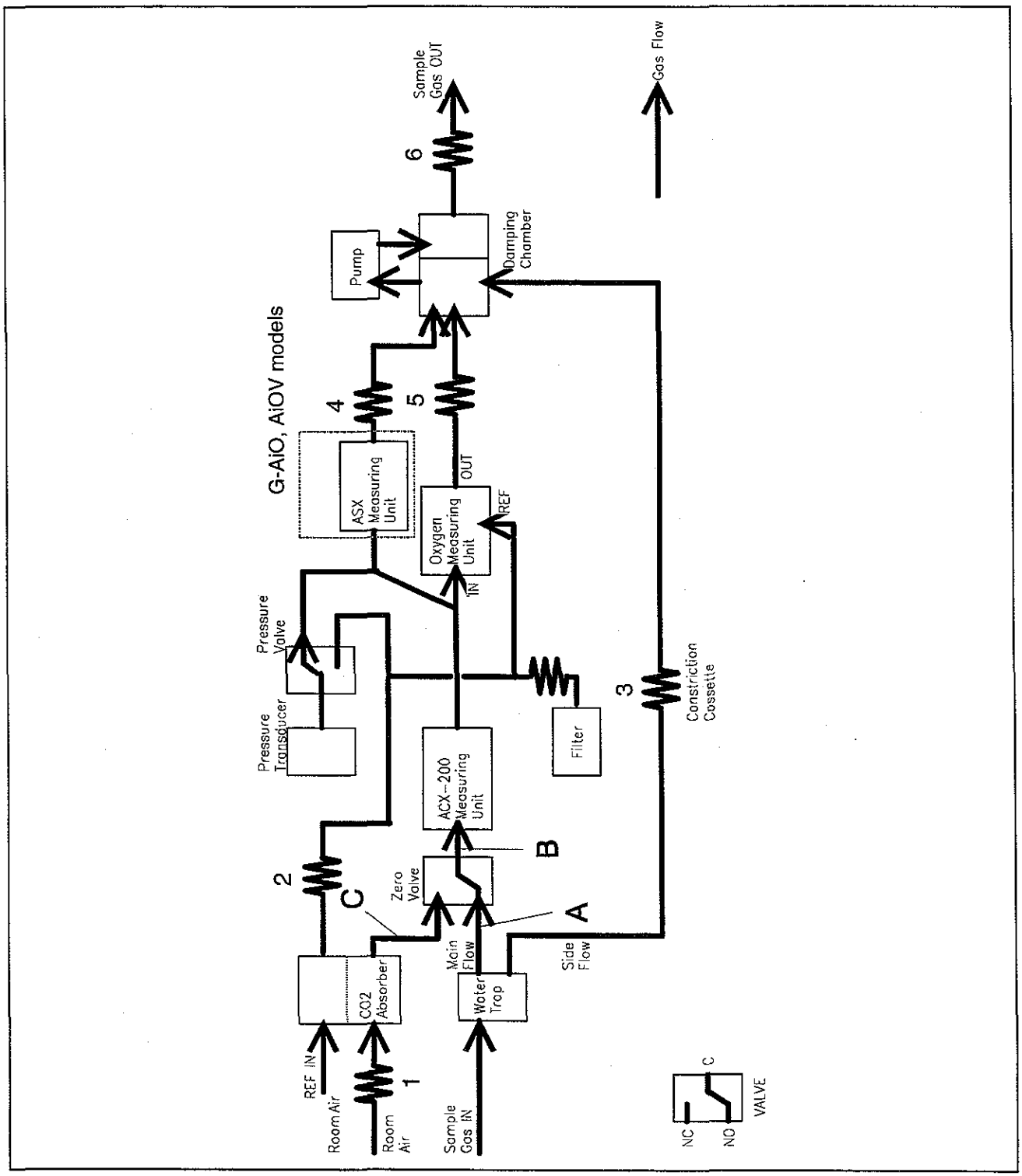


Figure 14 Gas Sampling System Adjustment Chart

Rate of the side flow is checked by blocking the side flow after the water trap and measuring the flow rate as above. The rate should decrease by 10 to 27 ml/min.

Measurement flow and reference flow of the oxygen measuring unit are checked as follows:

(a) Connect the flowmeter behind the flow cassette (no. 2) ahead of the oxygen measuring unit REF inlet. The flowmeter should show between 25 and 42 ml/min. The flow rate is adjusted by changing the cassette.

(b) Connect the flowmeter between the oxygen measuring unit IN inlet and the tube which is connected to it. The flow rate should be between 18 and 25 ml/min **larger** than the REF flow. This is adjusted by changing the flow cassettes (no. 4 and 5) which are located between the IN and OUT inlets.

(c) Flow rate of CO_2 absorber is measured by connecting the flowmeter to the unoccupied connector of the flow cassette (no. 1). Make sure that the monitor is in normal situation (APNEA text on the screen). The flow rate should be zero. When the gas zeroing takes place, the rate should be between 180 and 220 ml/min. The gas zeroing can be simulated in the ACX Service Menu manually (pump start, zero valve on). The flow rate is adjusted by changing the cassette (no. 1).

CAUTION: When changing cassettes make sure that the tubes are reconnected properly.

Flow to be adjusted	**Constr. No. (see Figure 14)**	**Nominal value (tolerance) ml/min**
sampling flow	6	200 (180 to 220)
side flow	3	10 to 27
O_2 measurement in	4 and 5	45 to 60
O_2 reference in	2	25 to 42
CO_2 absorber flow	1	180 to 220 when zeroing

NOTE: Changing any of the cassettes will have some effect on the other flow rates. After any adjustments check the other flow rates as well.

O_2 measurement flow pressure measurement

Gradual decrease of main flow rate due to the water trap filter clogging can be checked by measuring pressure difference between the O_2 measurement flow and the O_2 reference flow. Remember that the sampling line should be attached to the water trap before starting the test.

The pressure difference is automatically checked after every gas zeroing.

See ACX Service Menu chapter later in this manual for further information.

3.4.2 Oxygen Measurement Unit Adjustments

The only field service procedures for the O_2 measuring unit are the offset (zero), gain, and frequency adjustments. In case of any other trouble, the measuring unit should be replaced and the faulty one sent to Datex for repair.

Offset (zero) adjustment

Because the oxygen measuring unit is a differential sensor, which actually measures the difference between the O_2 concentrations in the sample and reference gases, its output must be adjusted to equal zero when atmospheric air is present at both inputs.

a) Connect a digital voltmeter to the output of the O_2 measuring unit at pin 7 of connector X4 on the Gas mother board.

b) Let the monitor draw in room air and adjust the voltage to zero with the O_2 measuring unit trim resistor designated 'ZERO' (see Figure 15) in the O_2 module PC board. The potentiometers are located at the same side of the measuring unit as the tubing connectors.

c) Perform gas calibration (refer to Operator's Manual).

Gain adjustment

a) Adjust the O_2 measuring unit offset as described in the previous section.

b) Sample 100 % oxygen and adjust the measuring unit output to between 7.7 V and 8.3 V with the trim resistor designated 'GAIN' (see Figure 15). If the output will not exceed 7.7V, it is acceptable that the output exceeds at least 5 V. At that level software is still able to compensate the output.

c) Check and if necessary readjust the offset and gain until the readings remain stable.

c) Perform gas calibration (refer to Operator's Manual).

Temperature compensation adjustment

Factory calibrated.

Frequency adjustment

The switching frequency of the electromagnet of the O_2 measuring unit has been selected to be 110 Hz to avoid interference from harmonics of both 50 Hz and 60 Hz mains frequency.

Fine adjustment is seldom necessary. However, if you wish to reduce the effects of mechanical resonance peaks of the cabinet which appears as high noise level of the O_2 measuring unit analog output (above 20 mV peak to peak) it is worth of trying the fine frequency adjustment. One turn of trimmer "FREQUENCY" will change the frequency by 1.5 Hz. Try to find minimum noise but do not deviate more than $\pm$5 Hz.

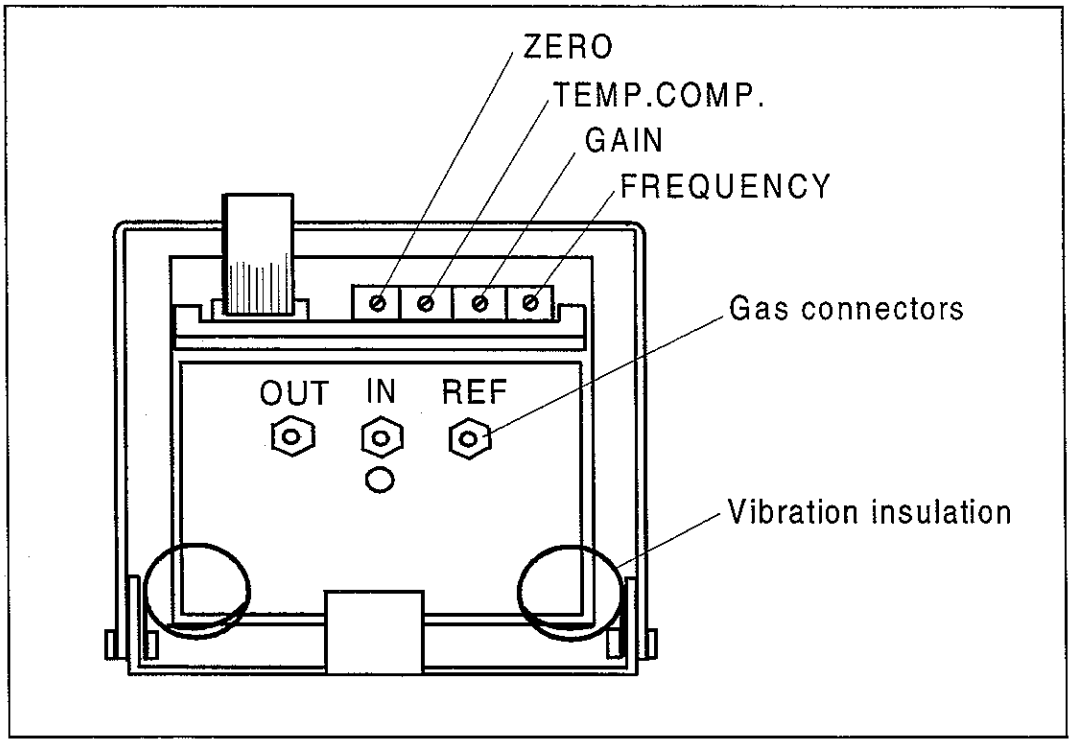


Figure 15 O_2 Measuring Unit Adjustments

3.3.3 Flow Calibration

PVX board is calibrated at the factory and due to the board's design calibration is not regularly needed. The calibration data is saved into the board's EEPROM memory and if the software EPROM of the board is changed the calibration must be performed. It is recommended to perform the calibration both with adult values using the D-lite, and with paediatric values using Pedi-lite.

a) Connect spirometry tube to the Airway module pressure and volume connector, and the D-lite sensor to it. To improve the accuracy, the endotracheal tube and all acessories which are in use with normal monitoring should be attached also during calibration.

b) Go to service menu: Monitor Setup -> Install Service (Password 16 - 4 - 34)-> Service View (26 - 23 - 8) -> Modules -> Gas Unit -> PVX -> Flow Calibration.

c) After the flow is zeroed ('Zero OK' message displayed) attach Calibration Pump or Spirometry Tester (code 884202) to the flow sensor (D-lite or Pedi-lite). To start the calibration select Adult or Paediatric sensor calibration according to the flow sensor used.

d) Set calibration volume for adult 1000 ml and for the pediatric patients 300ml.

e) Work on the calibration pump slowly, appr. 1 pump in 5 seconds, pump until 'adjust'-message appears. If you use the Spirometry Tester, perform the calibration according to the tester instructions.

f) Adjust the reading to match the calibration volume used (1000 ml for the D-lite and 300 ml for the Pedi-lite).

Press Normal Screen to return to waveform display.

4 TROUBLESHOOTING

4.1 General Troubleshooting Chart

TROUBLE	POSSIBLE CAUSE/TREATMENT
No response to breathing	Sampling line or water trap blocked or loose, or improperly attached. Water trap container full. Interface cable to monitor disconnected. See the Gas sampling system troubleshooting.
SENSOR INOP. message	The temperature is too high, check fan and filter at the rear panel Communication error, check timeout and bad checksum values at the service menu Check Airway Module connection cable, and supply voltages. Check ACX measuring board
xx ZEROING ERROR-message	Gas zeroing failed. Condensation or residual gases are affecting zero measurement. Allow module to run drawing room air for half an hour and calibrate again.
AIR LEAK-message	Air leak in sampling system. Probably water trap or the sampling line is not attached properly. Gas zero valve failure. Pump failure or gas outlet blockage. Supply voltage missing
REPLACE TRAP-message	Flow resistance increased due to residue built-up on water trap membrane. Replace the water trap.
REBREATHING-message	CO_2 concentration in inspiratory air is too high. Possibly CO_2 absorber in ventilation is saturated. Change the absorber.
OCCLUSION-message	Sampling line or water trap is occluded. Water trap container is full. If occlusion persists check internal tubing for blockages. Check the power supply voltages.
SELECT AGENT-message	No anaesthetic agent is selected though delivery is started. Vaporizer valve is broken. Traces of cleaning or disinfecting agent in the water trap container affecting the readouts. Replace the water trap.
No response to any gas	Sampling line, water trap, or internal tubing blocked or loose, or improperly attached. Pressure valve malfunction. Pump failure. Supply voltage missing. Serial communication error. Check those items.

TROUBLE	POSSIBLE CAUSE/TREATMENT
Sudden increase in gas display	Measuring chamber contamination. ±15 V supply voltages missing. Water trap malfunction. Check all internal tubing and the interior of the water trap for occlusions or leaks. Replace water trap. Check flow rates.
Abnormally high response to all gases (or abnormally low) or sudden occlusion warning	Pressure transducer failure. Exchange the ACX Measuring board.
Random output (resembling noise)	Chopper motor timing pulses out of sync. Chopper motor not running, motor faulty or connection loose. Chopper motor driver transistor C-E open circuit or current limiter short circuit. Exchange the ACX measuring board.
Strong drift in all gases	Leakage in the sampling line or internal tubing (especially in conjunction with too low readings). Exchange the ACX measuring board.

Supply voltage troubleshooting

TROUBLE	POSSIBLE CAUSE	TREATMENT
"Gas module removed" No Gas module exists after turning the monitor on.	+5V lost	Gas module CPU not running. Check Gas Interface cable. Check +5V from module mother board and timeout value from module service page.
Random CO_2 value. No CO_2 or AA response. Abnormal AA mixture messages and AA selections. "Unknown Agent" "Zero error" after zeroing "Calibrate Agent ID" "Sensor Inop"	+5Vdirty lost	Check the IR lamp resistance (approximately 4 Ohm)and the lamp voltage (module mother board connectors X8 and X9) X8 = ASX lamp(i-models) X9 = ACX lamp
"Continuous Occlusion" "Sensor Inop" Random curve trace and gas digit values(resembling noise). Pressure and flow curves extremely low.	+ 15V lost	Check voltage from module mother board X1 pin 4, X2 pin 1a, X3 pin 1a, X4 pin 9 and X5 pin 5.
CO_2 value high. "Air leak" "Sensor Inop" Paw and Flow curves extremely high.	- 15V lost	Check voltage from module mother board X1 pin 2, X2 pin 2a, X3 pin 2a, X4 pin 6 and X5 pin 6.
"Air Leak"-message remains on the screen.	+15V dirty lost	Check voltage from module mother board X1 pin 3, X2 pin30a , X3 pin 30a, X4 pin 1 and X5 pin 13.
Fan Stopped.	+32V lost	Check the fuse on Gas interface board. Check the fan and regulated fan supply voltage from module mother board connector X10.
"Calibrating gas sensor" remains on the screen.	One or more of the voltages lost: +5Vdirty, +15V,-15V, +15Vdirty ACX measuring board not communicating with the Gas mother board. ACX measuring unit badly contaminated.	Check those voltages as above. Check whether the ACX software version is available in the service menu. If not, replace the ACX measuring board. Replace the ACX measuring unit.

4.2 Gas Sampling System Troubleshooting

The faults which can occur in the sampling system are: leaks or blockages in the tubing, failure of the sampling pump or the magnetic valves, or diminishing of the flow rates because of pump aging or dirt accumulating in the internal tubing.

The following checks should help in localizing the fault. Whenever suspecting the sampling system and always after working on the sampling system check and if necessary adjust the flow rates.

The sampling system details are illustrated in Figures 4 and 5.

CAUTION: The special internal sample tube is mechanically fragile. Sharp bends will cause leaks.

NOTE: D-fend water trap should be replaced when the OCCLUSION message appears during the monitor startup.

NOTE: If any liquid has entered the ACX-200 measuring unit due to water trap filter failure, contact Datex Technical Services.

- Connect power cord and sampling line. Turn the power on and wait until the initialization is over.

1. SAMPLING SYSTEM LEAK TEST

1) Choose ACX Service Data page in the Gas Unit Service Menu.

2) Connect a tube to the sample out connector and drop its other end into a glass of water.

3) Block the sample inlet, reference flow of the oxygen measuring unit, and the CO_2 absorber port that draws room air in. Wait for one minute.
There should be less than 1 bubble per 10 seconds coming out of the tube. Bubble should not move upwards more than 11 mm per 30 seconds inside the tube. If it does, there is a leak between the pump and the sample out connector.

4) Perform leak test to the CO_2 absorber by opening zero valve. The maximum permitted leakage is the same as above.

CAUTION: Do not turn the pump off while performing the leak test. Negative pressure in the sampling system will suck in water in the glass.

2. WATER SEPARATION

1) Dip the patient end of the sampling line into water quickly (about a half second) three times at 45 seconds' interval. After that drop the end into water and lift it up when the sampling line is totally filled with water.

2) Check that all the water goes into the trap container and not into the monitor.

3. STEAM TEST FOR THE SPECIAL TUBES

Choose Halothane as anaesthetic agent and let the monitor sample room air. Then quickly feed air of 100 % relative humidity (for instance from a kettle in which you are boiling water) to the monitor. If the digital reading jumps as much as 0.1 % replace the special (Nafion) tubes.

Gas Sampling System Troubleshooting Chart

4.3 O_2 Measurement Troubleshooting

Because of the complex and very sensitive construction of the oxygen measuring unit no repairs should be attempted inside the unit. Instead, if the fault has been found in the measuring unit itself, it should be replaced and the faulty unit be sent to Datex for repair.

In cases of no response to O_2 or strong drift, check the tubing for loose connections, blockages and leaks.

CAUTION: Never apply overpressure to the O_2 measuring unit as the pressure transducer may be permanently damaged.

If the message 'O_2 zero error' is displayed check the O_2 measuring unit output voltage on Gas mother board (see Section Offset adjustment).

If the adjustment range of the (software) calibration is insufficient check the O_2 measuring unit output voltage and adjust the gain if necessary (see Section Gain adjustment).

If there are problems with O_2 response time check the O_2 measurement flow rate and adjust it if necessary (see Section Gas Sampling System Adjustments).

If the O_2 signal is noisy, check the measurement unit suspension. Frequency adjustment may help in some cases (see Section Frequency adjustment).

4.4 ACX Troubleshooting

CAUTION: The measuring unit ACX-200 can be repaired and calibrated only at the factory. Due to sensitivity of the measuring chamber surface, the measuring chamber of ACX-200 should not be attempted to clean with any detergent, not even with water.

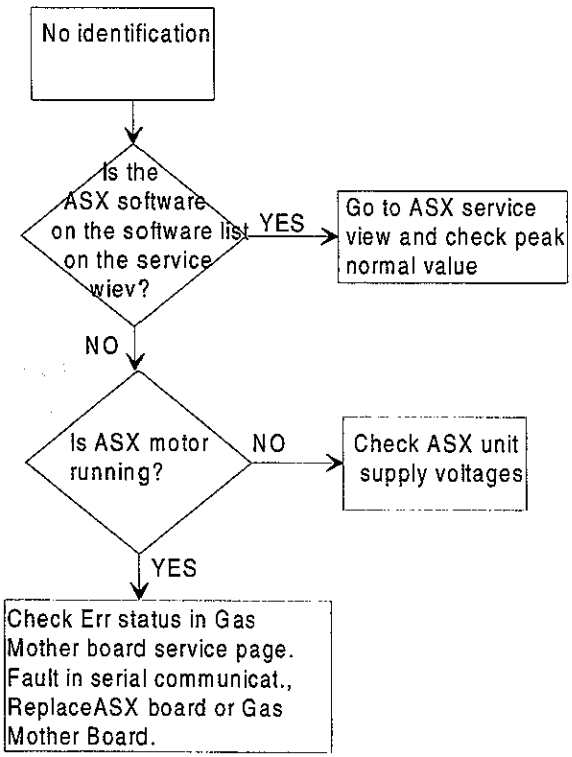
The ACX troubleshooting is carried out in the General Troubleshooting scheme. The ACX testing is explained at the ACX Service Information section, please refer to it.

4.5 ASX Troubleshooting

NOTE: Please read also troubleshooting section in Operator's Manual.

CAUTION: The agent identification bench ASX-200 can only be repaired and calibrated only at the factory.

TROUBLE	POSSIBLE CAUSE/TREATMENT
AGENT MIXTURE- message when calibration gas (Freon) is fed	Repeat calibration. If the module contains ASX-100, it is not capable to identify calibration gas R23, therefore the message. However, the ASX-100 will still calibrate with R23.
No response from ASX	Communication between ASX unit and Central Unit is lost. ASX bench disconnected or faulty. Check that the motor is running.



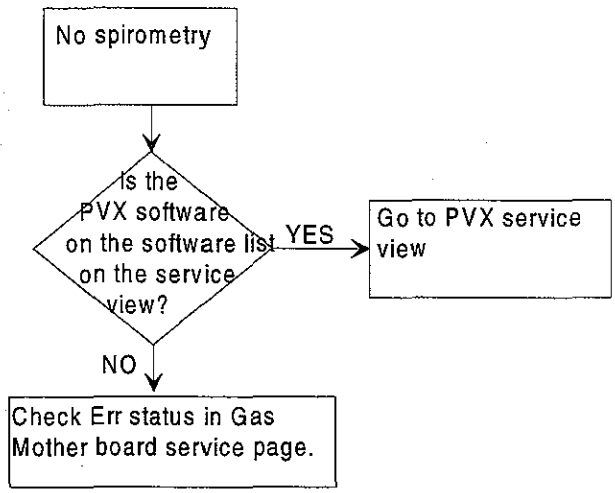
ASX Troubleshooting Chart

4.6 PVX Board troubleshooting

CAUTION: The measuring unit PVX-100 can be repaired and calibrated only at the factory.

NOTE: Never apply DIFFERENTIAL pressure higher than 25 cmH_2O to the spirometry tubing. Make sure that both spirometry tubes are always connected.

NOTE: Never apply overpressure or negative pressure of more than 300 cmH_2O to the spirometry tubing.



NOTE: The PWX software string does not appear onto the list when using the combination of G-AOV module and monitor software S-___94.

4.7 Gas Mother Board Troubleshooting

Due to the complexity of the LSI circuitry there are only a few faults in the CPU digital electronics that can be located without special equipment.

Check that the RAM, EPROM, CPU and other I.C.'s that are on the socket are properly.

See Gas mother board Service pages for more information.

Instructions After Replacing the Software or Gas Mother Board

After replacing the software or Gas mother board board:

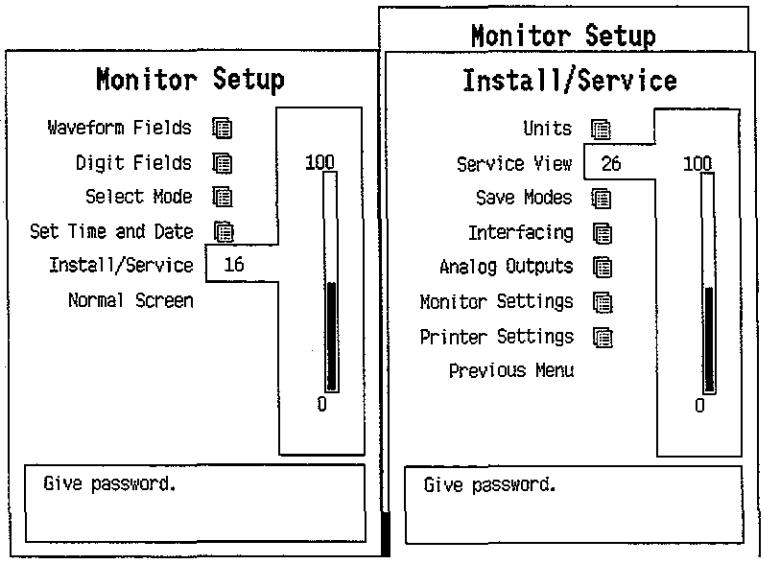
- perform the gas calibration.
- re-establish previously used settings or inform the monitor user that settings are default values.

4.8 Error Messages

MESSAGE	EXPLANATION
Occlusion	The sample tube inside or outside the monitor is blocked or water trap is occluded. If occlusion persists, measured gas values disappear.
Air leak	-the water trap is not connected -the gas outlet is blocked -there is a leak in the sampling line inside the module. If air leak persists measured gas values disappear.
Replace trap	Indicates residue build-up on the water trap membrane. This decreases air flow.
Zero valve error	Opening the valve does not change working pressure enough.
Gas calibration is not available during the first 5 minutes/during occlusion/during air leak	Calibration not allowed during the first 5 minutes after power up and in mentioned situtations.
Select agent	No agent selected
Continuous occlusion. Check sampling lineand water trap.	Occlusion over 40 seconds.
Air leak detected. Check water trap and sample gas out-flow. Press normal screen to continue.	Air leak over 40 seconds

MESSAGE	EXPLANATION
CO_2:	
Zero error	Unsuccessful zeroing
Unstable	Unsuccessful calibration
CO_2 over scale	CO_2 signal exceeds the maximum waveform area
O_2:	
O_2 zero error	Unsuccessful zeroing
O_2 over scale	O_2 signal exceeds the maximum waveform area
O_2 Unstable	Unsuccessful calibration
N_2O:	
N_2O zero error	Unsuccessful zeroing
N_2O Unstable	Unsuccessful calibration
Ane agents:	
AA zero error Zero error	Unsuccessful zeroing
AA unstable Unstable	Unsuccessful calibration
AA over scale	AA signal exceeds the maximum waveform area
Menu messages during calibration:	
Zero error	Unsuccessful zeroing
Adjust	Calibration gas accepted and monitor is ready for adjusting the gas values to match the calibration gas concentration
Unstable	Unsuccessful calibration

5 SERVICE VIEW



To enter Airway Module Service menu:

1. Press the MONITOR SETUP key.
   The Setup menu appears.

2. Turn ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34.
   The Install/Service menu appears.

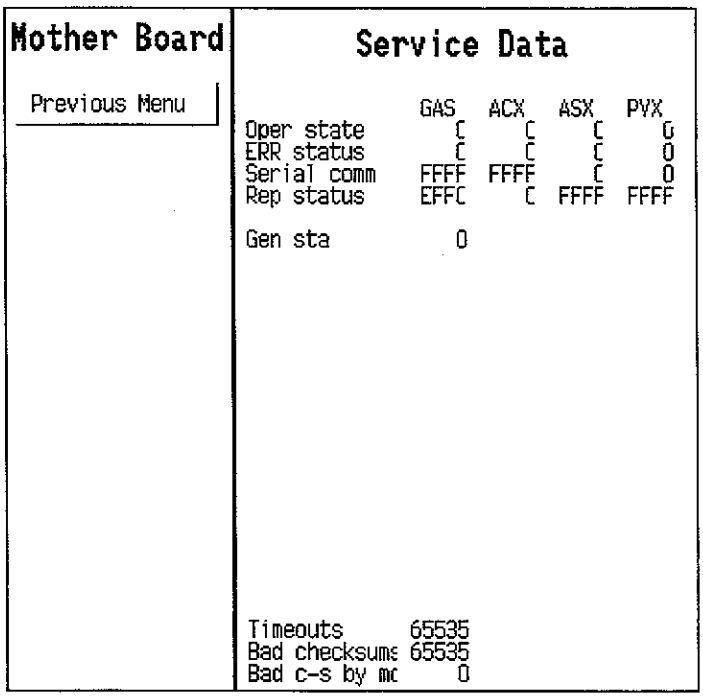
4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

6. Turn the ComWheel to highlight Modules and push.

7. Turn the ComWheel to highlight the Gas Unit and push.

5.1 Gas Mother Board



Service Data

Oper State

Internal operation state of the module:

0...9	function performed, if staying on, failure is indicated
10...29	Initialization
30...39	Normal operation state
40...49	Zeroing
50...59	Calibrating

Err status

Indicates measuring unit malfunction:

GAS: 0 no error
1 error in ACX measuring system
2 error in ACX communication
10 error in ASX measuring system
20 error in ASX communication
40 error in PVX measuring system
80 error in PVX communication
Possible failure source: Gas CPU, ACX, ASX or PVX.

ACX: 0 no error
if not 0, replace ACX unit

ASX: 0 no error
if not 0, replace ASX unit

PVX: 0 no error
if not 0, replace PVX unit

Serial Communication

Serial Copmmunication indicates a state of serial communication between the module processor and a measuring unit.

GAS: FFFF Continuously

ACX: FFFF Continuously

ASX: Value is for factory use only.

PVX: Value is for factory use only.

Rep status

Rep status is a four-digit number, where all digits, abcd , can have different values.

Gas rep status:

a: 0 No sevoflurane or desflurane measurement available
3 ACX can measure sevoflurane and desflurane

b: 0 No gas measurements available
F CO2, O2 N2O and AA measuremnts available
3 CO2 and O2 available

c. 0 No ACX, ASX, nor PVX board running
1 ACX board running
3 ACX and ASX board running
5 ACX and PVX board running
7 ACX, ASX and PVX board running

d 0 Normal operation state
1 Occlusion
2 Air leak
4 Other sampling system error
8 Replace trap

ACX rep status:

a empty Normal operation state
1 ACX initialization

b empty Normal operation state
2 Occlusion
4 Air leak

c C Normal operation state
others values used in manuafcture's testing

d 0 Normal operation state
others values used in manuafcture's testing

ACX rep status FFFF continuously

PVX rep status FFFF continuously

General Status 0 Normal operation state

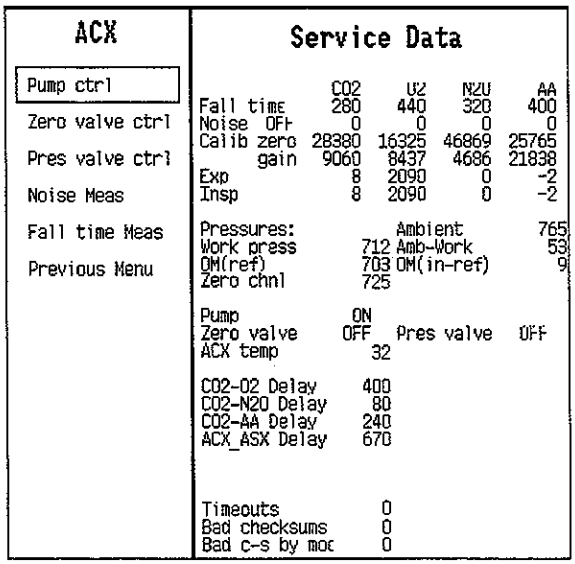
8000 Initialization

If not 0 or 8000, replace the Gas mother board.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.
Bad checksums is also a cumulative number that indicates how many times communication from the module to monitor broke down (first line) and from monitor to the module broke down (second line).
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting indicates either serial communication failure or module not in place.

The timeouts etc numbers should not grow faster than 50/s.

5.2 ACX Service menu



Menu items:

1. Turn pump on/off
2. Turn zero valve on/off
3. Turn pressure valve on/off
4. Noise measurement

5 Fall time measurement

6 Return to previous menu

Fall time

Fall time indicates the response time of the measuring units. Select 'Fall time meas' from the menu. Notice that text 'feed' appears under each gas. Feed the calibration gas until every 'feed' is replaced by 'start'. Remove the sampling line quickly from the gas source.

Check that fall times are:

O2 < 480 ms

CO2 < 360 ms
N2O < 360 ms
AA < 520 ms

NOTE: The measurement can be performed only with the modules using module software 884295.

Noise measurement

O2, CO2 and N2O

Feed the calibration gas until the gas values are stabilized on screen. Start the measuring by selecting 'Noise meas' from the menu. After 10 seconds stop measuring by reselecting 'Noise meas'. Close the gas source. Noise values should be: O2< 100, CO2 < 20, N2O< 150.

AA

Select halothane for anaesthetic agent. Feed the room air until gas values are stabilized. Perform the noise measuring as above, the value should be < 20.

NOTE: The measurement can be performed only with the modules using module software 884295.

Calib zero and gain

These values are calibration constants of zero and gain for each gas. The zero values may change at gas zeroing, the gain values at gas calibration.

Exp, Insp

Gas concentration value from the ACX measuring unit

Pressures

Ambient is the ambient pressure measured at the initialization. **Work press** is the internal pressure of sampling system measured by the ACX measuring board pressure transducer. Typically the value is appr. 700 mmHg. The difference between these two pressures is **Amb-Work** and if the pump is functioning, it should be > 40.

OM(in-ref) is a pressure difference between the O_2 measurement flow and the O_2 reference flow. This pressure difference is automatically checked after every gas zeroing and it should be between 5 to 10 mmHg. If the pressure difference turns negative a message 'Replace trap' is displayed when the limit of -5 mmHg is exceeded.

Pump, zero valve, and **pressure valve** are operated manually by highlighting and pushing the ComWheel. During patient monitoring, the valves are in OFF position

ACX temp indicates temperature inside the ACX bench, and the value is typically + 10 °C higher than the prevalent room temperature.

Delays indicate the time delays within or between measuremnt units.

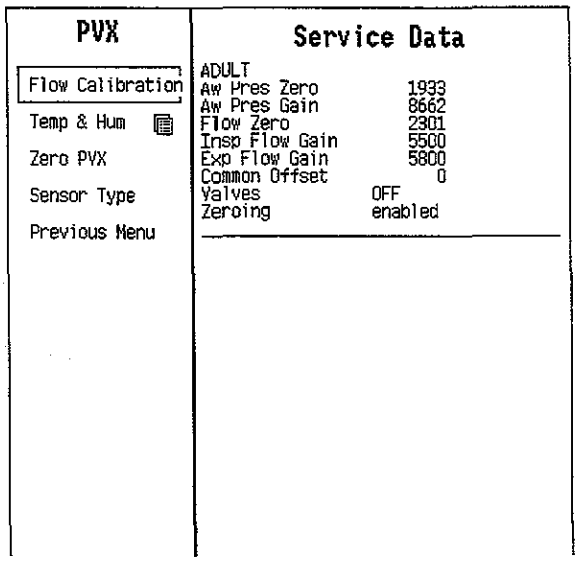
Delays are measured at the same time as fall times.

Check that the ACX_ASX delay is between 400-800.

NOTE: The measurement can be performed only with the modules using module software 884295.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.
Bad checksums is also a cumulative number that indicates how many times communication from the module to monitor broke down (first line) and from monitor to the module broke down (second line).
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50 per second) indicates either serial communication failure or module not in place.

5.3 PVX Service Menu



Menu items:

1 Flow Calibration service data

2 Humidity and temperature service menu

3 PVX zeroing

4 Sensor type selection

5 Return to previous menu

Flow Calibration Service Data

Aw Pres Zero...The value of airway pressure zero is changing within the range of 1000 to 2400.

Aw Pres Gain...Gain of pressure measurement. This value should be fixed to 8662.

Flow Zero....The value corresponds to the pressure transducer B1 output during PVX zeroing. Number 0 corresponds to 0 V and 4095 corresponds to 10 V. The value is typically within the range of 100 to 4000.

Insp Flow Gain...Gain of inspired gas volume. Typically the value is between 5000 and 9000 depending on which sensor is used (adult/pediatric).

Exp Flow Gain...Gain of expired gas volume. Typically the value is between 5000 and 9000 depending on which sensor is used (adult/pediatric).

***Common Offset**...Cancels common error which is caused by pressure from the pressure transducers. This is a transducer's own constant. The value should be between -230 and +230.

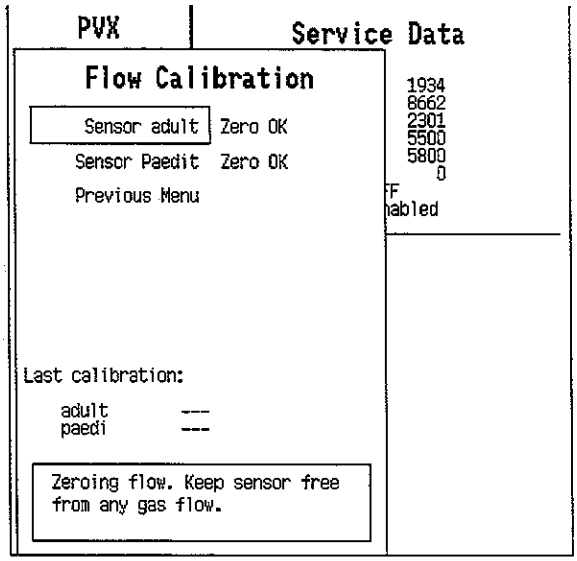
Valves...Position of zero valves.

Zeroing....Automatic zeroing is cancelled (disabled) or active (enabled).

NOTE: Items marked with asterisk (*) are not to be changed.

NOTE: The shown values are for the Adult module only. Changing the mode does not change the values.

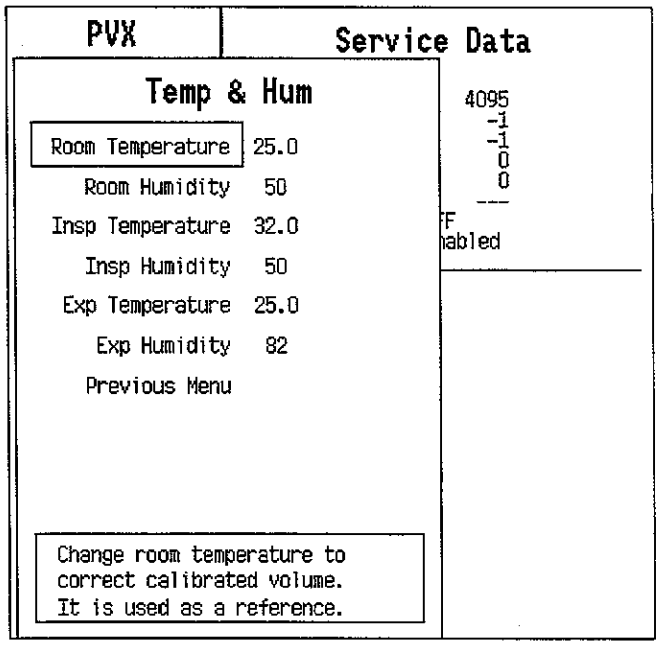
Flow Calibration



For information on the flow calibration, please refer to section 3.3.3, Flow Calibration.

NOTE: The last calibration dates are saved into the main CPU board memories. The information is not saved permanently.

Temp & Hum Service Menu



If circumstances noteceably differ from normal, or additional accuracy is required, the use of Temp & Humidity menu may be advisable.

Especially small errors in tidal values may indicate that temperature and humidity settings of the monitor differ too much from the used system.

Room Temperature and **Humidity:** these are needed only in calibration procedure.

Insp Temperature: The setting regarding the temperature of inspired gas. The value is used in calculations. Change if necessary.

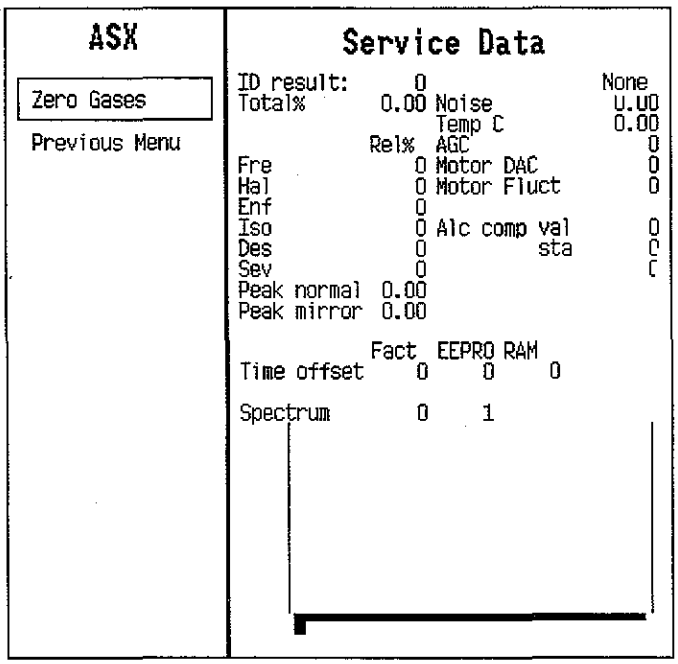
Insp Humidity: The setting regarding the humidity of inspired gas. The value is used in calculations. Change if necessary.

Exp Temperature: The setting regarding the temperature of expired gas. The value is used in calculations. Change if necessary.

Exp Humidity: The setting regarding the humidity of expired gas. The value is used in calculations. Change if necessary.

5.4 ASX Service Menu

NOTE: The ASX Service Menu in monitor software S-___94, S-___95 and S-___96 supports only modules equipped with the ASX-200.



1 Zero gases

2 Return to previous menu

Service Data

ID result displays the identified gas or mixture

Total % is the anaesthetic agent concentration measured by ASX bench.

Rel % is the relative percentage of each measured agent in the mixture.

Noise value should be less than 80. Check the value only when no gas is fed and after a minimum of one minute stabilization time.

Temp C is the temperature inside the ASX unit.

AGC (Automatic Gain Control) should be between 100 and 3500.

Motor DAC is a motor speed control voltage, 100...3900, and **Motor Fluct** is the speed fluctuation, should be < 200.

Alc comp val is the compensation factor for alcohol content measured during halothane, enflurane or isoflurane measuring. **Sta** shows the status of compensation, 0 means off, and 1 means on.

The value without a leading text is for factory use only.

Peak normal, Peak mirror give the place of the spectrum's peak in the channel numbers. The peak normal value should be 10.3-10.7 with calibration gas R23, and 12.9-13.1 with R22. If the value is not within the range, the cas calibration must be performed (see Operator's manual for instructions).

Time offset is the time between motor synchronization pulse and filter 0° angle. **Fact** is the factory value for it, **EEPRO** is the user calibration result, stored in the ASX, and **RAM** is the user calibration result, stored in the gas mother board.

Spectrum values tell about the scales of the spectrum display.

6 SPARE PARTS

6.1 Spare parts list

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the booklet AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

Airway Modules

G-AO Rev. 01, G-AiO Rev. 00

Item	Item description	Order No.
14	Gas mother board, G-AO / G-AiO	*(880352) Use 885174
6	ACX-200 measuring board	*880270
26	ACX-200 measuring unit	*879849
22	ASX-100 agent indentification unit	*881107
21	Lamp, ASX-100/200	*878756
25	Sample pump, Airway module	*881298
23	O2 mesuring unit	*(872898) Use 888511
7	Cover, top protection	878859
12	CO2 Absorber, Airway Module	*880067
13	Damping chamber / Filter	880068
10	Valve, pressure	*58534
9	Valve, zero	58534
11	Internal sampling tubings incl. system plate	*880375
	Nafion tube (A or B, 500 mm: see Serv. Man.)	*733383
	Nafion tube (C, 300 mm)	*733382
	Spring for D-Fend	875598
20	Front panel unit, G-AO	(880374) Use 887477
20	Front panel unit, G-AiO	(881116) Use 887477
	Membrane keypad, G-AO / G-AOV	879371
40	Fitting plate, G-AiO / G-AiOV / G-O / G-OV	880550
19	Plug, tube connector	880294
1	Rear panel sticker, Airway module (Eng)	880460
1	Rear panel sticker, Airway module (Ger)	880462
1	Rear panel sticker, Airway module (Fre)	880461
17	Front panel sticker, small, G-AO / G-AOV (Eng)	880376
17	Front panel sticker, small, G-AO / G-AOV (Ger)	880546
17	Front panel sticker, small, G-AO / G-AOV (Fre)	880454

17	Front panel sticker, small, G-AiO / G-AiOV / G-O / G-OV	880471
18	Front panel sticker, large, G-AO	880377
18	Front panel sticker, large, G-AiO	880472
4	Fan	880049
3	Case, Airway module	878864
24	Grommet for tubes	65094
8	Latch for flow casettes	880343
27	Connector, sample gas out	871981
31	Cross recess screw M6x16	61678
32	Bushing, AS/3 Airway Module	879512
	Thumb screw, AS/3 Airway Module	879511

G-AO Rev. 02, G-AiO Rev. 01, G-AOV Rev. 00, G-AiOV Rev. 00

Item	Item description	Order No.
14	Gas mother board, G-AOV / G-AiOV	*(881775) Use 885174
20	Front panel unit, G-AOV	(880374) Use 888292 [1)]
20	Front panel unit, G-AiOV	(881116) Use 888292 [1)]
37	Repair set for spirometry connectors, AS/3	*886978
28	PVX-100 without software	*881444
29	PVX tubings	882723
30	PVX board support	880435
18	Front panel sticker, large, G-AOV	881300
18	Front panel sticker, large, G-AiOV	881301

G-AO Rev. 03, G-AiO Rev. 02, G-AOV Rev. 01, G-AiOV Rev. 01

Item	Item description	Order No.
14	Gas mother board, AS/3 Airway module	*885174
35	EMC cover, Gas mother board	884116
33	Bronze plate	884117
34	Insulation plate for 884116	879914

G-AO Rev. 04, G-AiO Rev. 03, G-AOV Rev. 02, G-AiOV Rev. 02, G-O Rev. 00, G-OV Rev. 00

Item	Item description	Order No.
22	ASX-200 agent indentification unit	*882718
23	O2 mesuring unit	*888511
36	Grounding spring	885602
20	Front panel unit, G-AO	(885280) Use 887477
20	Front panel unit, G-AiO	(885281) Use 887477
20	Front panel unit with metal SSS -connectors, AS/3	888292 [1)]
20	Front panel unit w/o SSS -connectors, AS/3	887477
38	Spirometry connector, short male	886636
39	Spirometry connector, short female	886638

29	PVX tubings	885867
1	Rear panel sticker, Airway module (Spa)	886187
1	Rear panel sticker, Airway module (Swe)	885984
1	Rear panel sticker, Airway module (Dut)	886123
1	Rear panel sticker, Airway module (Ita)	886762
1	Rear panel sticker, Airway module (Fin)	888879
17	Front panel sticker, small, G-AO / G-AOV (Spa)	884405
17	Front panel sticker, small, G-AO / G-AOV (Swe)	885843
17	Front panel sticker, small, G-AO / G-AOV (Dut)	886065
17	Front panel sticker, small, G-AO / G-AOV (Ita)	886760
17	Front panel sticker, small, G-AO / G-AOV (Fin)	888876
17	Front panel sticker, small, G-AiO /-AiOV / -O / -OV	880471
18	Front panel sticker, large, G-O	885233
18	Front panel sticker, large, G-OV	886972

The Flow cassette's and their order numbers can be found listed in the Gas Sampling System - section of this manual.

* = the part is recommended for stock

[1] **NOTE:**
In case only the plastic spirometry connectors need repair, or compatibility with adult&paediatric Side Stream Spirometry accessories is needed, the **Repair set for spirometry connectors, order number 886978,** is recommend to be used.

The Front panel unit , order number 888292, does not contain a membrane keypad, fitting plate and small front panel sticker. Those should be added separately according to the Airway module type and revision.

Gas Interface Board, B-GAS

Item description	Order No.
Fuse T4A 250V	*51134
Grounding plate	885404

6.2 Exploded view of the module

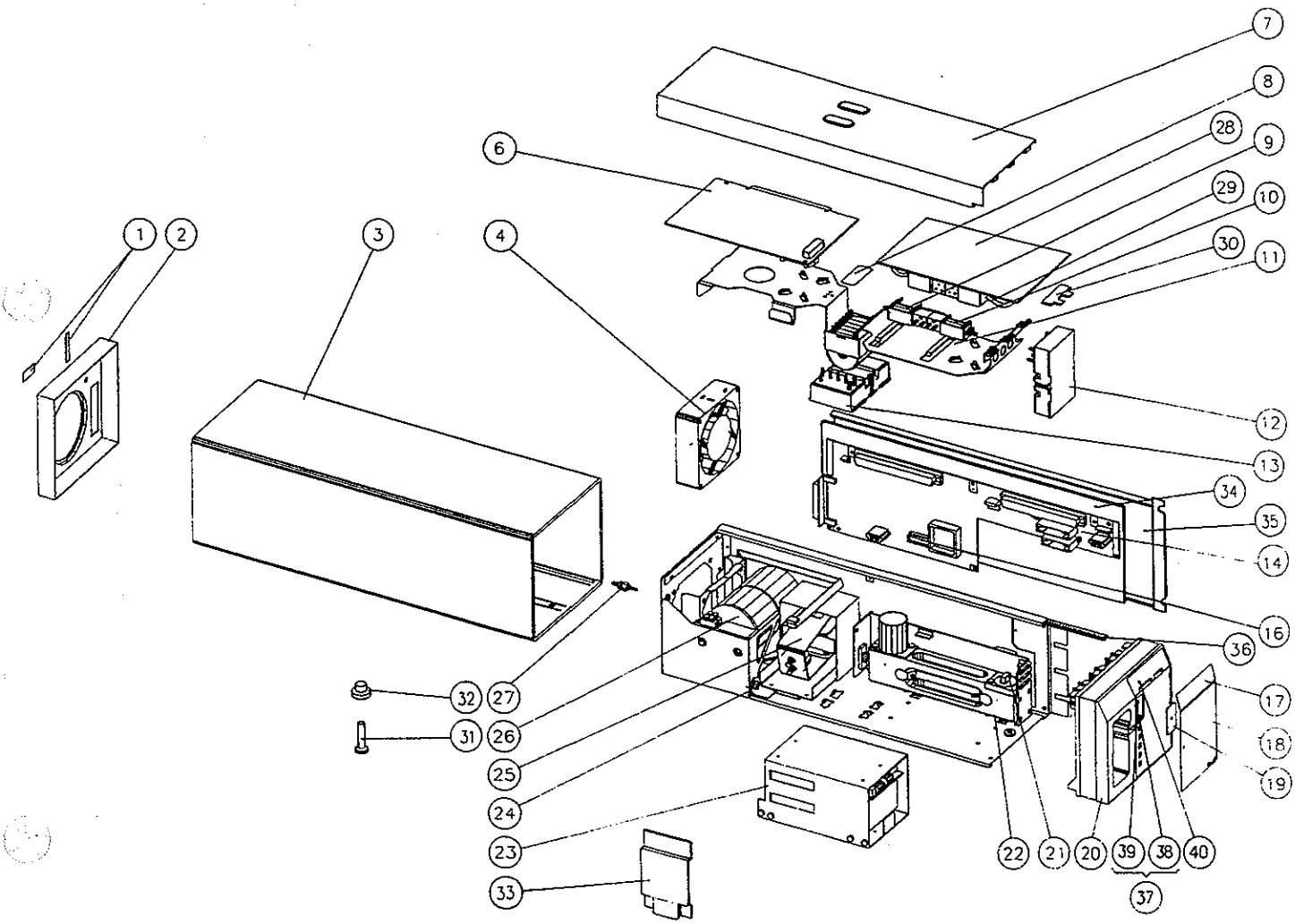


Figure 16 Exploded View of the Airway Module

7 EARLIER REVISIONS

This manual supports all the other Airway Module revisions except the following ones. For further information on those revisions see corresponding manual.

G-AO Module revision 01	Service Manual p/n 880850
G-AiO Module revision 00	-"-
G-AO Module revision 02	Service Manual p/n 882580
G-AiO Modules revision 01	-"-
G-AOV Module revision 01	-"-
G-AiOV Module revision 01	-"-